SCIENTIFIC AMERICAN
No. SUPPLEMENT 400

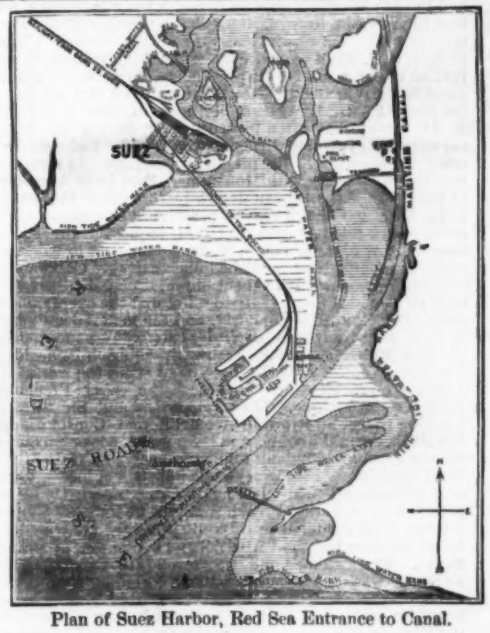
Scientific American Supplement, Vol. XVI., No. 400.
Scientific American, established 1845.

NEW YORK, SEPTEMBER 1, 1883.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

Plan of Port Said Harbor, Mediterranean Entrance to Canal.

FERDINAND DE LESSEPS.

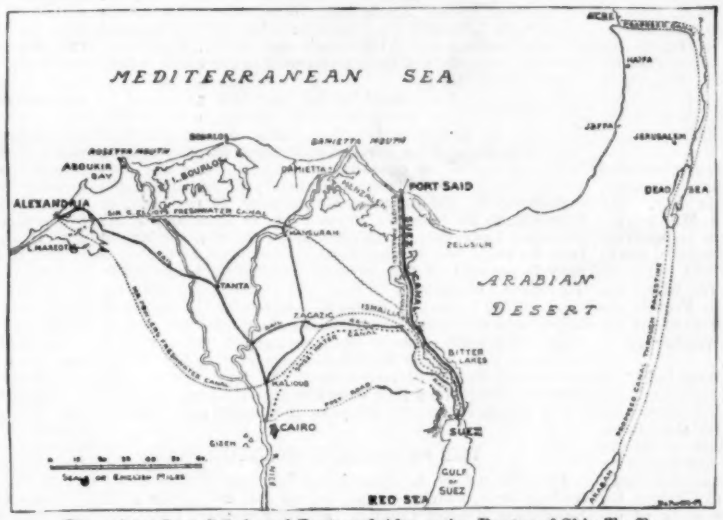


Plan of Suez Harbor, Red Sea Entrance to Canal.

THE SUEZ CANAL.

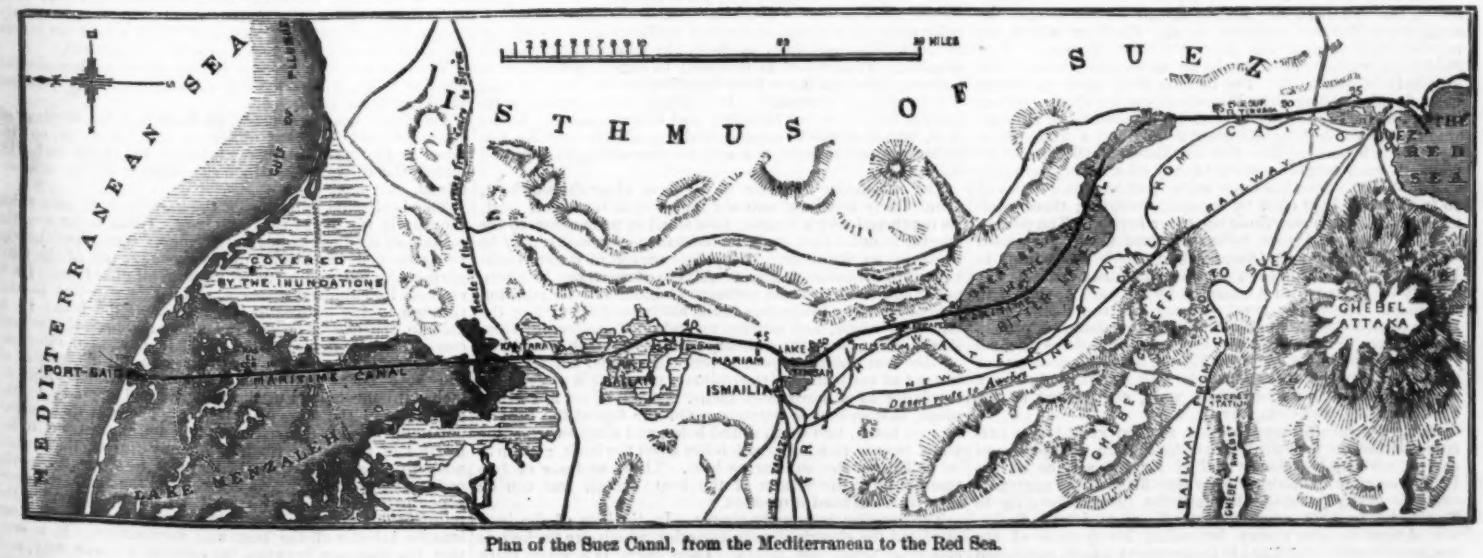
CONSIDERABLE excitement has recently been occasioned, both among politicians and among British ship owners and others interested in Eastern maritime traffic, with regard to the terms of a proposed agreement between her Majesty's Government and the Suez Canal Company, represented by M. Ferdinand de Lesseps, the president, for the construction of a second waterway alongside of the existing canal, to be aided by an advance of eight millions sterling from the British Government. There is no difference of opinion concerning the utility of this work, by which the up and down traffic would be enabled to proceed along parallel lines of canal without obstructing each other; but many influential persons consider that, in return for the pecuniary assistance given by Great Britain, the company ought to be required to make a speedier and larger reduction of its tolls, about four-fifths of which are levied upon British shipping; that England ought to have a greater part in the direction and management of the company; and that the company's exclusive privileges, under the concession it obtained from the Egyptian Government, ought not to be extended to a further period of time. These questions will soon come before Parliament, whose assent is needful to ratify the proposed agreement. In the mean time we present a few illustrations of the actual situation and works of the existing Suez Canal, with a brief account of its construction.

The plan shows the whole course of the Maritime Canal, from Port Said on the Mediterranean coast to Suez at the upper end of the Red Sea, with the small Fresh Water Canal from Ismailia to Suez, and with the adjacent country. The upper side of this plan is to the east. The entire length of the Maritime Canal is not quite a hundred miles. The first piece of it, from Port Said to Kantara, runs through the shallow Lake Menzaleh, the bed of which has been excavated to the required depth along a line of twenty-nine miles, forming a navigable channel protected by dikes on each side. All this tract of country is low and flat, being the eastward portion of the delta formed by the ancient mouths of the Nile, frequently overflowed, and half composed of mud, half of lagoons varying in extent at different seasons. Leaving this region of Lake Menzaleh, at Kantara, a station on the desert route from Egypt to Syria, the course of the canal for two miles is through low sand hills. It then enters Lake Ballah, traverses it for a distance of eight miles, and next enters a deep cutting from El Ferdane to Lake Timsah. Near El Guisr, four miles south of El Ferdane, the deepest cutting had to be executed, from 60 ft. to 70 ft. deep. On the shore of Lake Timsah, half way from Port Said to Suez, is the new port and little town of Ismailia, which is the headquarters of the Suez Canal Company in Egypt, and the residence of its local managers. It is here that the Fresh Water Canal, from the Nile below Cairo, approaches the Maritime Canal, and dispenses part of its water, through pipes laid along the northern section, to supply the inhabitants of Port Said as well as the stations and shipping on the Maritime Canal. The remainder



Plan of the Suez Canal, and Projected Alternative Routes of Ship Traffic.

Transverse Section of Suez Canal.



Plan of the Suez Canal, from the Mediterranean to the Red Sea.

THE SUEZ CANAL AND ITS ENTRANCES.

of the course of the Fresh Water Canal, as shown in our plan, winds round the western shore of the Bitter (or Salt) Lakes, and through the Chalouf cutting to reach the town of Suez. The Maritime Canal, however, cuts directly through the rising ground of Toussoum and the Serapeum; thence passes twenty-four miles through the Bitter Lakes, which are of sufficient depth, having been filled by letting in the water of the Mediterranean; finally penetrates the last piece of high rocky ground by the cutting of Chalouf, and twelve miles further on arrives at the Red Sea, a mile below the town of Suez.

The projector, the creator, and hitherto the supreme director of the Suez Maritime Canal is the Vicomte Ferdinand de Lesseps, one of the most extraordinary men of the age, and whose portrait is most worthy to appear in our journal. He was born at Versailles, in 1805, and was employed in the French Consular Service in Egypt, in the time of Mohammed Ali, from 1836 to 1840. He was afterward Consul at Barcelona, next French Minister at Madrid, and in 1849 Special Envoy to Rome, when the French military intervention took place for the restoration of the Papal Government. In 1854, when Said Pasha became Viceroy of Egypt, M. De Lesseps, who knew him intimately, was invited to pay a visit to Cairo. There, living as an honored guest in the Viceroy's palace, he conceived the project of the Suez Canal. It was an old idea of Napoleon I., and M. De Lesseps had often turned it over during his former sojourn in Egypt, but without ever having had leisure to study the question in its practical bearings. In a pleasure trip which he made with Mohammed Said from Alexandria to Cairo across the Libyan desert, he broached the subject to his host, and the Khedive, perceiving at a glance all the profit which might accrue to Egypt, requested the Frenchman to draw up a memoir. M. De Lesseps set to work, and eighteen months later published his admirably elaborate and yet concise book, "Percement de l'Isthme de Suez." In this, all the advantages that would attend the opening of the canal were exposed luminously, and the material difficulties of the enterprise were so carefully entered into and disposed of, that Mohammed Said, seeing the thing to be decidedly feasible, empowered M. De Lesseps to begin the work. The political obstacles which now beset the eager Frenchman were very formidable. Lord Palmerston and Sir Stratford Canning (Lord Stratford de Redcliffe), at Constantinople, did all they could to oppose it. No assistance or encouragement was afforded by any influential party or class in England; merchants, shipowners, capitalists, engineers, as well as politicians, set themselves against it. But M. De Lesseps persevered, and the French nation, under the Emperor Napoleon III., entered readily into the scheme, which also found favor in Italy and Austria, and in other Mediterranean States. The "Compagnie Universelle du Canal Maritime de Suez" was thus formed, with an original share capital of eight millions sterling; but it raised four millions additional by debentures, and received nearly four millions from the Viceroy of Egypt as indemnity for his non-fulfillment of some of the conditions of the contract. The canal, with its ports at each end, was to belong to the company for ninety-nine years, from 1869, after which it would revert to the Government. Of the traffic earnings, the Egyptian Government was to receive annually fifteen per cent. The Fresh Water Canal was, at first, made the property of the Suez Canal Company, but was afterward relinquished to the Government for a pecuniary compensation. The total cost of the works was seventeen millions sterling.

The work of construction was designed and superintended by French engineers, with two or three Italian assistants. The engineer-in-chief was M. Voisin or Voisin Bey. The line was divided into four sections, of which M. Laroche, M. Gioia, M. Berthoult, and M. Larousse were respectively the resident engineers. The contractors for the canal works were Messrs. Borel, Lavalley & Co.; the contractors for the Port Said harbor works, Messrs. Dussaud. The whole was completed in 1869, when the Empress of the French, the Emperor of Austria, and princely representatives of all the great nations of Europe were present, on November 17 of that year, at the splendid opening ceremony.

Some particulars of construction may here be added. The canal has a uniform depth of 26 ft. 4 in., and its bottom has a uniform width of 72 ft. 5 in., which does not allow two large ships to pass each other, except at certain places, where a wider basin is formed. The full width at the surface of the water is 329 ft. 2 in., as shown in our engraving of the section; but, where the canal was cut through rocky ground at El Guisr and the Serapeum, and at Chalouf, the upper width is reduced to 200 ft. 11 in. The work of excavation was at first done by hand, by thousands of Egyptian laborers; but latterly, by the aid of floating dredges and other mechanical contrivances, it was more quickly and economically performed. The vast natural basin of the dried up Bitter Lakes, twenty-four miles long, was converted into an inland sea, in March, 1869, by admitting the waters of the Mediterranean. Their Royal Highnesses the Prince and Princess of Wales visited the canal during this operation, and the Prince was there on a later occasion.

Port Said and Suez, the two harbors that form, respectively, the northern or Mediterranean entrance and the southern or Red Sea entrance to the Maritime Canal, are represented in two of the plans we have engraved. Port Said is quite a new creation, being constructed since 1859 expressly for the canal. The town is built upon an island or sandbank dividing Lake Menzaleh from the Mediterranean Sea. The harbor is entirely artificial, formed by two breakwaters, one a mile long, the other a mile and a half, which were made by casting into the sea about 25,000 blocks of concrete, each weighing above twenty tons. They inclose a space of 570 acres, the outer harbor, which has a depth of 26 ft. or more, kept clear by constant dredging; three sheltered basins inside constitute the inner harbor. The port of Suez had for many years, before the Suez Canal, been used by the Peninsular and Oriental Company's steamships to India, and by the French Messageries steamers. It was already connected with Alexandria by railway, as shown in the map. The works here required for the Suez Canal traffic consisted of a breakwater, 850 yards long, to protect the entrance to the canal; also the deepening of the channel from the anchorage in Suez Roads; and embankments or sea walls to inclose space for docks and basins, including a dry dock, 360 ft. long and 85 ft. wide, constructed by the French Messageries Company.

Such, described in mere outline, are the great works executed within the past thirty years by French enterprise and capital, which have chiefly availed for the service of the British mercantile marine, nearly four-fifths of the aggregate tonnage yearly passing through the canal belonging to England. In 1875, when the late Khedive, Ismail Pasha, was obliged to raise money by selling his portion of the company's stock, the British Government wisely purchased his shares at the price of nearly four millions sterling. These shares, however, do not yet entitle their holders to receive dividends, or to vote among the other shareholders in the company, but they will do so after the year 1894. We now come to the recent history of the negotiations which have resulted in the provisional agreement explained in the House of Commons by the Chancellor of the Exchequer, which is dated July 10, 1888. Sir Charles Rivers Wilson and Sir John Stokes, the two English official Directors on the Board, in the months of April, May, and June last, had repeated consultations with M. De Lesseps on the improvement of the canal communication between the Mediterranean and Red Seas, and the conditions under which the canal must be hereafter worked. The views suggested in Lord Granville's instructions and those of the President and Vice-President of the Canal Company approximated so closely that they were invited to London to confer with the Chancellor of the Exchequer and the President of the Board of Trade.

The points to which attention was directed were: 1. The improvement of the canal accommodation across the isthmus, so as to meet the increasing requirements of commercial traffic. 2. A substantial reduction of the dues and tolls. 3. An increased share in the government of the company. Improved communication may be obtained by one of three methods: (1) By the simple widening and deepening of the present canal. (2) By the construction of a second canal on ground forming part of the company's concession, which would lead to the new channel not being on the most advantageous line; and (3) the construction of this second parallel canal on ground outside the boundary of the company's territory, but which would allow of the channel being traced in the best direction for the navigation and for economy of construction. Either of the two first alternatives was open to M. De Lesseps to adopt, without any fresh concession from the Egyptian Government, and therefore without the necessity of having recourse to any agreement with her Majesty's Government for their good offices. From the moment that such intervention was rendered possible by an understanding on other points, the third alternative appeared to be the only one deserving of consideration. It is sufficient to mention the obvious advantage resulting from a system which secures to vessels two distinct and efficient routes, one for the outward, and the other for the homeward traffic.

The number of steam vessels that passed through the canal, out and home, in the year ending with last April was 3,154, having an aggregate tonnage of 4,889,923 tons. Of these vessels, 2,469 were British, with 3,781,905 tons; 197 were French, with 382,855 tons; 111 were Dutch, with 199,473 tons; 115 German, with 144,732 tons; 65 Italian, with 119,370 tons; 81 Austrian, with 112,115 tons; 42 Spanish, with 75,340 tons; and 74 of all other nations, with 74,183 tons, including Russian, Belgian, Turkish, and Chinese, in which last mixed class there is a falling off since the preceding year. The British shipping in the year ending April, 1882, was in number 2,484, in tonnage, 3,512,857. In the year ending April, 1881, there were 1,714 British ships, with 2,390,974 tons burden; when the total canal traffic of the year was 2,158 vessels and 3,023,772 tonnage. The vast proportion of British shipping to the whole is thus steadily maintained.

The receipts of the canal for the year 1882 amounted to about £2,500,000, of which nearly £2,000,000, or four-fifths, was paid by British ships. The year's working expenses were £730,000. After certain deductions for the sinking fund and interest on consolidated coupons, there was a net profit of £1,260,000. This profit of the year was distributed as follows: To the Egyptian Government, 15 per cent., or £188,000; to the founders, 10 per cent., or £126,800; to the directors, 2 per cent., or £25,320; and £25,320 to the invalid fund for employes; leaving to the shareholders of the company 71 per cent. of the net profit, amounting to £900,000. This gives a divident of 56 francs 22 centimes per ordinary share (of 500 francs), 31 francs 67 centimes to the founders' shares, and 83 francs 73 centimes to the preference shares. There are 400,000 shares in the company, of which 176,602 shares are held by the British Government; and these are not entitled to any dividends until the year 1894, the late Khedive, from whom they were purchased, having alienated his dividends for twenty-five years in advance from 1869.

THE SUBMARINE MONITOR.

PROFESSOR J. H. L. TUCK is the inventor of an electrical torpedo boat, which is described as follows by the U. S. Submarine Monitor Company, of San Francisco, Cal. The use of electricity as a motive power has given a strong impetus to invention, especially to invention that is concerned with machinery to produce motion. One of the first results is to be seen in the electric railroad, in which the effort has been made to increase the speed and safety of locomotion while the cost is reduced. But electricity, as a motive power, has rendered possible other means of locomotion besides those already existing, not the least important being that which is submarine. This, however, will be found especially valuable in military and naval operations, where protection from danger or freedom from observation is principally desired; and almost the first application of electricity to navigation has been made in the case of a submarine monitor. This vessel is designed to afford protection to harbors, although it can take the offensive on the high seas if it be thought necessary. It is simple in construction, requiring little time for building, and is inexpensive. A trial boat, which would be capable of doing effective service, can be built in two months, at a cost not exceeding ten thousand dollars.

The submarine Monitor is an iron cigar-shaped boat, about thirty feet long and six feet deep in its widest part. Its depth and width is made thus small in proportion to the length, in order that as little resistance as possible may be presented to the water. Its appearance out of water would be that of an immense cigar. At the stern there is a propeller and rudder of the ordinary fashion, and in addition a second rudder projecting horizontally backward, like the tail of a whale, and moving up and down instead of from side to side, as does the ordinary rudder. Beneath the middle of the boat there is a second propeller placed horizontally, instead of vertically, as the ordinary propeller is placed, and revolving in a horizontal plane, instead of on a vertical plane, as does that at the stern. On the top of the boat is an iron hatch, two small round holes, and a hollow iron pipe about twenty feet long, which lies upon the back, as it may be called, of the submarine boat. These, and one or two small holes at the bottom of the boat, are all that can be seen from outward inspection.

The interior is equally simple. In the bow of the boat are fitted the electric storage batteries, which are packed as closely as small salt boxes. Then there is a small force pump worked by hand or by electricity, which can be used either for air or water. Next there is, apparently, a box suspended from the top, and having a water-tight door opening into the interior of the boat. Next comes a simple piece of machinery, which is an ordinary dynamo, consisting of a cylinder revolving between the poles of a magnet. To this revolving cylinder is connected the shaft of the propellor at the stern. Near by is a small wheel, with simple accelerating gear, worked by hand. Still further back are the tillers to the two rudders, and the helmsman's seat. Just above the seat is a glass tube, bent in the form of a V, one arm of which is attached to the top of the boat. This is all that constitutes the vital parts of the submarine boat, and are all so simple that they can be understood at a glance. There is no complicated machinery, and nothing but the simplest principles of mechanism have been brought into use. By the use of clutches both propellers can be run by the same dynamo, or a separate dynamo can be used for each propeller.

By this simple machinery, a journey can be made beneath the surface of the water. The boat is built with such reference to her specific gravity that when lying idly in the water only a small part of the convex top, like the back of a turtle, appears above the surface. There is situated an air-tight air or water lock, through which entrance is had to the hanging box, whence the interior of the Monitor is reached. The boat can be caused to sink beneath the surface in three ways. The first, and most obvious, is to let the water into water-tight compartments, which increases the specific gravity of the mass, and readily causes it to sink. A second method is to connect the electric engine with the propeller beneath the bottom of the boat, which, by revolving in a given direction, draws the boat beneath the surface to any depth desired. The third method can be used only when the boat is in motion. When forced ahead by the propeller at the stern, if the blade of the horizontal rudder is inclined downward, the water striking it from beneath would force the stern up, and the bow being then inclined downward, the course of the Monitor would be downward. By simply reversing the process the boat can be made to rise to the surface. Incline the horizontal rudder upward, and the boat's bow is pointed toward the surface. Cause the propeller beneath the boat to revolve in the opposite direction from that before given, and the Monitor rises in a straight line. With the force pump, throw the water in the compartments through the side, and the same result is produced. The ordinary propeller and the ordinary rudder act as in all vessels, with which every body is familiar. Motion is produced by the electric engine, whose power is conveyed by insulated wires from the storage batteries at the bow of the boat. In case of accident, the propellers can be worked efficiently by means of the hand-wheel and accelerating gear. Progress through the water, either beneath or at the surface, is thus secured. But it is necessary to be able to direct one's course beneath the surface, and to tell exactly where one is. Of course the ordinary mariner's compass will enable the boat to be directed in any given direction on any horizontal plane; but this will not serve to keep the boat in the same plane, or to cause her to reach any plane desired. The ability to cause the boat to sink to any desired distance, and to keep it constantly at that distance from the surface, is given by the simple glass tube, depending like a V from the top of the boat. This is a simple instrument, based on the principle of the barometer, to measure the pressure of the water. The pressure of the water increases from the surface downward, as does the pressure of the air, and by graduating a tube containing mercury, which is exposed to the pressure of the water, it is as easy to ascertain one's depth beneath the wave, as it is by the barometer to learn his height above the level of the sea. By carefully watching the mercury in this glass, which is open to the surrounding water, the Monitor can be made to keep an absolutely horizontal course beneath the surface. By it the depth reached is ascertained, and by it any given depth can be attained. Thus all motions of the boat are under full control.

The air supply is obtained in a simple and effective manner. In the first place, compressed air is taken, stored in suitable receptacles, which will serve for the use of the three or four men who man the Monitor, for a long while. But this supply is kept in reserve for a long stay far beneath the surface of the waters. A supply of fresh air is secured ordinarily, while the boat is beneath the surface, by means of the hollow iron pipe that was described as lying at length on the top or back of the boat.

When the Monitor is sunken fifteen or eighteen feet beneath the surface of the water, this iron pipe is raised perpendicularly by a simple gearing, and the bottom comes in position over a valved opening, leading to the interior of the boat. As the Monitor is only fifteen or eighteen feet beneath the surface, and as the perpendicular pipe is twenty feet long or more, its top projects above the water. By opening the valve and attaching the double air-pump, fresh air can be drawn into the interior of the Monitor, while the vitiated air can be expelled by the same pump, through a valved exit provided for that purpose. Thus, a supply of fresh air can be obtained while the Monitor is wholly out of view, with the exception of a foot or two of pipe that is scarcely larger than ordinary gas pipe, and which would not attract the attention of any person a hundred feet distant.

The interior of the boat is lighted by an incandescent electric lamp, which neither consumes air, nor produces smoke or heat.

Provision has been made, as described, for shaping the course of the boat in any direction; but as there are no windows in the craft, further provision has been made, by which the direction in which she ought to go can be ascertained.

This is effected by means of the hanging box, over which the trap in the top of the boat closes. When under way, the captain of the boat stands in this compartment, and the trap being opened, his head projects above the top of the boat, giving him an unobstructed view in all directions. He is clothed in submarine armor, and air is supplied to him through tubing leading to the interior of the boat. He is able to see clearly everything above and around him, and can shape the course of the vessel in any given direction. He communicates with the helmsman in the interior of the boat by means of a telephone, which is easily attached to the helmet used by divers, and operated by the electricity in the storage batteries. There is thus perfect communication between the captain and the persons in the interior of the boat. Should, for any reason, the captain wish to enter the interior of the boat, he closes the hatch, opens a valve which allows the water in the box to escape to a compartment below, where it can be forced out by the pump. The box being emptied of water, he opens the door into the interior of the boat, and steps within. It is seen that the distance between the captain, when on duty, and the interior supply of air and electricity is so small, and the

protection to tubes and wires is so great, that there is no danger of his air supply being cut off, or of his telephone refusing to do its work.

The crew of the torpedo boat need not exceed three men, a helmsman and two men to manage the air and water pumps and keep everything in order. The captain is the person on whom devolves the responsibility of directing the boat, and performing the work of attaching the torpedo. But this is easily done. The torpedoes are composed of dynamite, and are made in compact form, so that they can be easily handled. They are made after two plans, by one of which they are firmly attached to a vessel's keel, and by another they are made buoyant; and by this tendency to rise to the surface, are made to stay in place under a vessel. In attaching a torpedo of the first kind, the torpedo boat is directed by the captain beneath a vessel, and allowed to rise until the keel above him is within his reach. Then the torpedo is firmly fixed to the keel of the doomed vessel by clamps, and the torpedo boat sinks and runs away beneath the water, reeling out behind her wires that are connected with the torpedo attached to the ship.

When at a safe distance, an electric current is sent through the wires, and the torpedo is exploded; accomplishing its work as throughly as dynamite can do it. When it is for any reason found inadvisable to use torpedoes of the clamp variety, the floating torpedo is used. This consists of two parts, each of which is made buoyant with cork, and attached together with a rope or other flexible material. They are placed in position by the captain, who allows one to rise on one side of the keel and the other on the other side, where they are kept in place by their connecting cord, and by their tendency to rise, which causes them to press up against the vessel's bottom. They are exploded in the same way as is the other torpedo. It is thus readily seen, that this method of attacking armored vessels is as effective and as sure as it is safe and inexpensive. The torpedo boat can work against vessels that are in motion or at rest. It is capable of making ten or twelve knots per hour, and can readily keep pace with large iron clads.

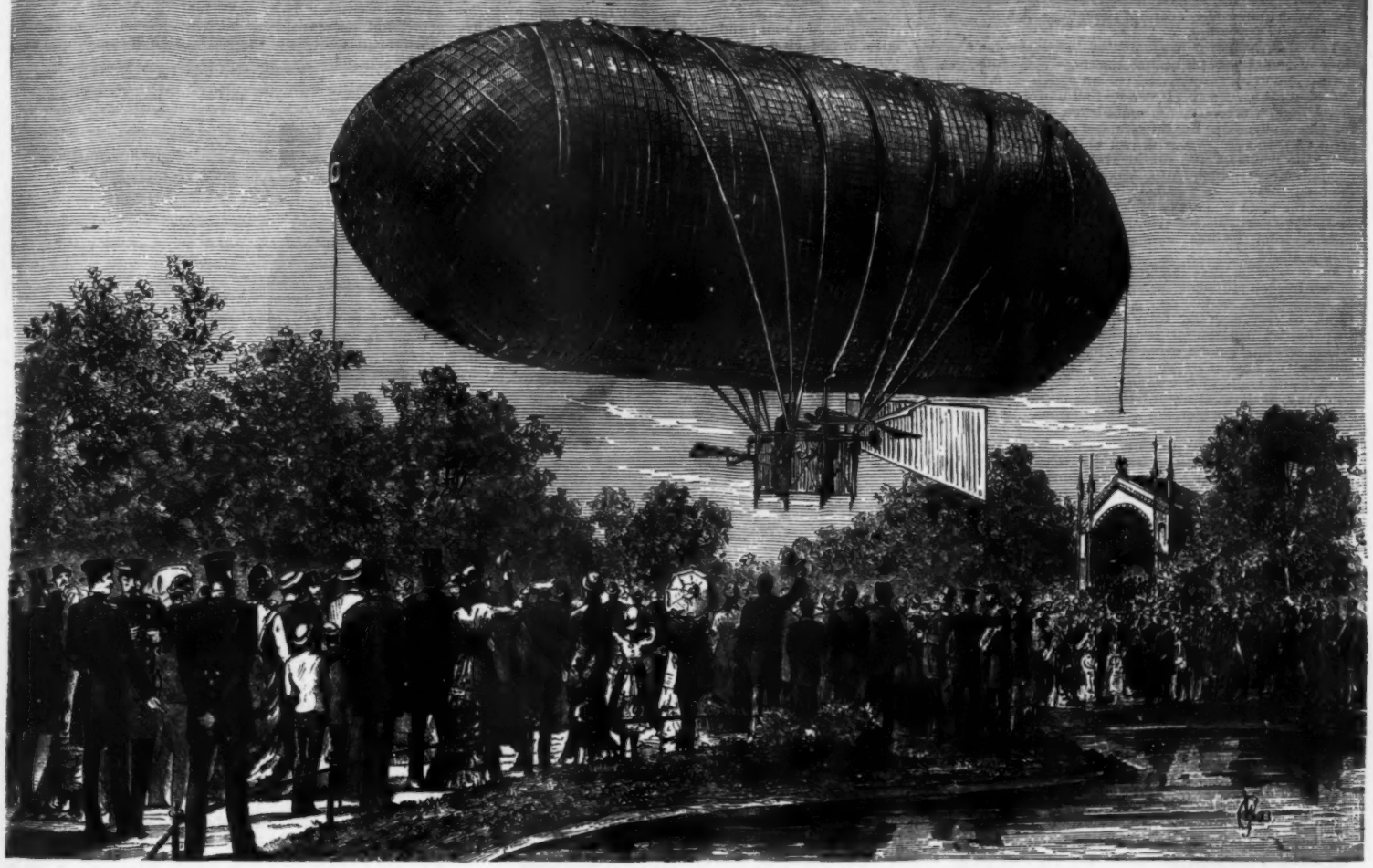
WOELFERT'S NEW AERIAL SHIP.

On the 5th of June, 1783, just one century ago, the first ascension in a balloon was made. Since that time thousands of balloons have followed that first one, and many improvements have been made for governing balloons and propelling them backward and forward.

The late Franco-German war was the cause of many and great experiments made in that line. Some inventors have devised means for steering and governing ordinary pear shaped balloons, and others have constructed vessels resembling birds or fishes in appearance, which vessels are propelled by means of gas or electric engines, thus providing a machine which can be raised and lowered and moved about at will. The first class of balloons, which are not provided with any motors and have the usual shape, must contend with the wind, which exerts great pressure on the large surface of a balloon; and the latter class of balloons must be provided with very light, compact, and strong machinery, which has sufficient power, not only to raise itself, but also the balloon, the fuel, and the attendants. Many attempts have been made in practice to steer ordinary balloons, but experiments with the bird and fish style of balloon have been made with models only, and not on a large scale.

Dr. Woelfert, of Berlin, built a silk balloon and departed from the usual shape, making his vessel in the shape of an enormous caterpillar. A series of belts surround the balloon, which is provided with two rods which really form the backbones of the same. The belts and ropes support a basket or car made of cane, on which basket a very large rudder made of sail-cloth is held. A transverse rod extends through the basket, and, on the ends of the same, metal, screw-shaped wings, which are proportionally very small, are fastened, which can be adjusted laterally or vertically, and are to be operated by the feet of the person in the basket or car.

Dr. Woelfert made three ascensions in the early part of June last, at the Hasenheide, near Berlin, Germany, but did not succeed in propelling the balloon against the wind, nor in keeping it stationary when the wind was strong. Either the screws were too small, or Dr. Woelfert did not have sufficient power to operate them; but, nevertheless, his experiment was a very interesting one.—*Ueber Land und Meer.*



DR. WOELFERT'S NEW AERIAL SHIP.

THE JOINTING AND TESTING OF GAS-MAINS.*

By C. W. FOLKARD, Assoc. Royal School of Mines.

THE conveyance of fluids through closed pipes, under pressure, has effected quite a revolution in one of the most important concerns of daily life, viz., water supply; enabling engineers to dispense with the cumbrous and costly aqueducts employed by the ancients, and reducing the outlay to such an extent as to render the system applicable to villages. For this purpose sound mains are necessary; otherwise the loss by leakage is a bar to the financial success of the undertakings. Fortunately, however, a serious leak in a water-main soon makes itself visible, except under special conditions of soil; but in gas-mains this is not the case to anything like the same extent. Sound mains are therefore of the utmost importance to gas companies; and in the present paper it is proposed to examine, somewhat in detail, the methods of jointing and testing now in use. This is all the more necessary at the present time, in consequence of the tendency toward centralization of manufacturing stations; otherwise the leakage from the great length of trunk main necessary for the supply of outlying districts more than counterbalances the increased economy of manufacture in large works.

A theoretically perfect main would be one formed in lengths, like lead or composition pipe, by expelling molten lead or alloy through a mandrel. Each length would be jointed to the next by a stuffing box or other contrivance, to allow of expansion and contraction. Practically, however, the great majority of mains (both water and gas) are of iron jointed with lead; so we will first consider the effect of changes of temperature on ordinary lead joints.

It is well known by water-works engineers that leaks regularly occur in certain parts of their districts in the spring and autumn; and if we examine these parts, we shall find that the soil is clay, and so the water finds its way to the surface, and attention is directed to the leak. But it is quite obvious that the same causes are at work all over the country; the difference being that, when the soil is porous, the water finds its way underground and unnoticed. This view is fully borne out by the fact that in London, when anything is required to be done in the sewers, a time is always chosen when the service-pipes are not charged. Exactly the same thing occurs with gas-mains, but unfortunately the effects are seldom apparent until the main is examined; for, owing to the porosity and deodorizing power of the soil, the gas escaping into the atmosphere is composed of the inodorous compounds, marsh gas, hydrogen, and carbonic acid. Every one who has taken up a main which has been buried for some years, even when originally well laid, must have been struck with the great number of joints either actually leaking or which have been leaking, as evidenced by the color and smell of the soil around them.

When we examine the theory of the matter, we shall see that it cannot be otherwise. Let us take a four-inch pipe, the outside of the spigot being 4¾ inches in diameter, the inside of the socket 5⅛ inches in diameter, and the joint ⅜ inch thick. When run with lead and set up, we have a ring of lead ⅜ inch thick between two rings of cast iron. When first made it is absolutely gas-tight; but inasmuch as the coefficients of expansion of the two metals differ considerably, changes of temperature are fatal to its soundness. As to the limits of the range of temperature in the ground at about two feet deep, it is well known that in severe winters water-mains are frozen solid. We may therefore fairly assume that the temperature of the ground falls to 30° Fahr. in winter; and if we take 60° Fahr. as the maximum in summer, we have a range of 30° Fahr. Iron expands $\frac{1}{1705}$ of its length, and lead $\frac{1}{1176}$ (more than twice as much) for this range; and consequently when the temperature has risen 30° Fahr. the three-eighths inch lead ring, instead of being 0·375 inch, tends to become 0·37518 inch. The socket, by the same rise of temperature, viz., 30° Fahr., becomes 5·5011 inches, and the spigot 4·7500 inches, the space between, viz., 0·7502 ÷ 2 = 0·3751, for the lead ring. This, however, as we have just seen, has expanded (or would have done if free to do so) to 0·37518 inch; consequently the yielding lead is squeezed out of the joint, which will probably remain tight. But when the action is reversed, viz., by a fall of temperature, it is evident that a space is left between the lead and the socket 0·00008 inch wide, through which gas or water can pass.

It is a well known fact that large joints—*i. e.*, those in which the interval between the socket and spigot is (say) three-fourths instead of three eighths inch—always give a great deal of trouble from leakage, the amount of which is far more than doubled when the size of the joint is doubled; and the experiments of Poiseuille on the flow of liquids and gases through capillary tubes afford an explanation of this fact. The minute space between the lead joint and the socket caused by change of temperature may be looked upon as a capillary tube 2 or 2½ inches long, and Poiseuille found that in capillary tubes of this length the flow of gas was proportional to the fourth power of the diameters. Consequently, if this view is correct, the leak caused by variation of temperature in a three-fourths inch joint would be four times as great as in a three-eighths inch joint, instead of simply double. This, at all events, shows the desirability of putting the large spigots in the large sockets, and not laying the pipes haphazard. Another fruitful cause of leaks is the absence of any provision for the longitudinal expansion and contraction of the main. In subways and other situations where the changes of temperature are very great, expansion joints have been found to be indispensable, but this has not been considered necessary under ground, consequently the lead joints in old mains are frequently forced outward, and a leak is the result. These unsatisfactory results are a consequence of systematic defiance of physical laws.

* A paper read at the recent meeting of the Gas Institute, Sheffield.

At first sight it would seem to be a very easy matter to devise a permanently gas-tight joint; but, unfortunately, this is by no means the case; indeed, I believe there are few more difficult problems. In the first place, it is evident from the foregoing considerations that the use of two metals is inadmissible, owing to their different coefficients of expansion. Consequently we are limited to elastic substances like India-rubber, or rust joints for iron mains, and soldered or screwed joints for very small mains and services. With regard to India-rubber, it is generally considered that the benzole vapor in the gas would act upon the joint and produce leakage. This, however, is not the case with the vulcanized material; and this form of joint has the advantage of allowing for both longitudinal and transverse expansion and contraction. There is an account of the practical application of the substance as a jointing material for mains in King's "Treatise on Coal Gas" (vol. ii., p. 358); but the results are so extraordinary as to lead to the conclusion that either the station meter must have registered incorrectly, or some mistake have been made in the calculations.

In the case of iron cement, there would be no difficulty with regard to the transverse expansion, the material of the pipe and joint being similar. But stuffing boxes would be required at intervals to allow of longitudinal motion caused by change of temperature. These might be inclosed in small brick pits to allow of tightening up and repacking periodically; but as the motion would be very slight, it is probable that, if made with asbestos or similar durable material, the stuffing-boxes would not require attention for many years, and so the brickwork would be unnecessary. To give notice of leakage, a three-fourths inch pipe might be brought up to the surface fitted with a cap like a siphon-pipe, and examined periodically. By the use of lead service-pipes laid in wooden troughing, it would be possible, in the majority of cases, to dispense with all joints between the main and the main-cock in the consumer's house.

The foregoing remarks are merely intended as suggestions. The subject (simple as it seems) is a most difficult one, and requires much careful thought, which its great importance fully justifies.

The disturbance of gas mains by the subsequent operations of contractors for drains, sewers, water-mains, etc., is a very important subject, and one on which, in my opinion, legislation is necessary. It is not at all unusual to find small mains broken across by the subsidence of trenches opened for these purposes. But the escape of gas in such cases is so great that attention is soon drawn to the spot. When, however, the result of the subsidence is merely to disturb or partially draw the joints, the leaks may go on for years, and the total loss to the company is probably far greater than when the main is actually broken. The average loss of gas by leakage per joint per diem is about one cubic foot; and judging from the great number of joints which on examination afford evidence of leakage at one time or another, I am of opinion that the bulk of the unaccounted-for gas is lost in such minute leaks as would take place by changes of temperature acting on the iron and lead. It would, I think, be very desirable to pass a law rendering it compulsory (under substantial penalties) upon contractors and others opening public roads to give notice to the local authorities of any main laid bare by their operations. The local board would then communicate with the gas or water company, as the case might be, and a check would be kept upon the way in which the work was done. It might even be specified in what way the main should be protected against subsidence, especially in cases where the line of drain or sewer, etc., made a less angle than (say) ten degrees with the line of main. Such a law would only be affording a fair protection to companies. At present legislation is entirely on the other side.

Of course such modifications of the existing practice of main-laying would involve additional outlay; but the value of the gas saved by reduced leakage, when capitalized, would be found to represent a very large sum indeed, which would be available for employing more perfect methods of jointing, allowing for expansion and contraction owing to changes of temperature, etc.

We now come to the second division of the subject, viz., the testing of gas-mains. This is a far more delicate operation than in the case of water, and unless proper precaution be taken, it is very easy to condemn a tight main or pass a leaky one. These remarks apply only to the testing of dead mains (usually of large diameter) with compressed air; small mains being generally tested by filling them with gas and applying a light to each joint. When laid, the main is, of course, full of air at a pressure equal to a column of water thirty-four feet high or thereabout. If we pump air into the main till the water gauge shows eighteen inches pressure, it is evident that the absolute pressure in the main is 34 feet + 18 inches = 426 inches; and, by Boyle's or Mariotte's law, if the pressure in the main falls (by leakage) one inch, we know that $\frac{1}{426}$ part of the total air in the main has leaked away. Knowing the diameter and length, we can thus easily calculate the leakage in cubic feet per hour for a given fall of the gauge.

The following table shows at a glance the amount of leakage in cubic feet per hour corresponding to a fall of one inch per hour, viz., from 18 to 17 inches per 100 yards of main of various diameters:

Diameter of main in inches	Area in square feet.	Capacity of 100 yards in cubic feet.	Leak in cubic feet corresponding to 1 in. fall in gauge.
4	0·0872	26·16	0·061
6	0·1963	58·90	0·138
9	0·4418	132·54	0·311
12	0·7854	235·62	0·553
18	1·7672	530·16	1·240
24	3 1416	942·48	2 210
30	4·9090	1472·70	3·460
36	7·0680	2120·60	4·980
48	12·5660	3769·90	8·250

If the main is 200 yards long, the leak indicated by 1 inch fall of the gauge is twice as great. When we have (say) 5 miles of 30-inch main to test, 1 inch fall on the gauge represents a loss of 304·4 cubic feet; and consequently one tenth inch fall in an hour represents 30 cubic feet loss per hour, or 720 cubic feet per diem. It is evident, therefore, that at least one hour's duration of test is necessary; and this being so, we must now examine the effects of changes in atmospheric temperature and pressure.

It is generally impossible to test an exposed main satisfactorily in this manner, owing to the rapid changes of temperature; but when the trench is filled in, or even if the main is just covered with soil or water, the hourly changes in the atmospheric temperature have no perceptible influence on the gauge. With the variations of the barometer it is otherwise; and to test a large main properly, a good barometer (preferably an aneroid) is essential; since variations in the height of the mercurial column to the extent of 0·02 and 0·03 inch of mercury per hour are of daily occurrence, and occasionally the range is much greater. Mercury being about 13 times as heavy as water, bulk for bulk, the above figures correspond to a rise or fall of 0·26 and 0·39 inch per hour on the water-gauge. The main, in fact, acts similarly to a water barometer. When the atmospheric pressure rises, the water in the gauge attached to the main is depressed, and *vice versa*. Turning to the table, we find that one inch fall per hour in 100 yards of 30-inch main represents a leak of 3·46 cubic feet per hour, and consequently 0·26 inch fall in five miles of 30-inch main represents 79 cubic feet per hour. That is to say, five miles of perfectly tight 30 inch main would show a leak of 79 cubic feet per hour (1896 cubic feet per diem) owing to a rise of 0·02 inch per hour in the barometric column. On the other hand, if the atmospheric pressure at the time of testing happened to be falling at the rate of 0·02 inch of mercury per hour, the main would apparently be tight, although leaking at the rate of 79 cubic feet per hour.

Before making the one-hour test it is essential to allow half or one hour to elapse after pumping in the air, unless this latter operation has extended over three or four hours. This interval is necessary to allow the air to find its normal temperature, as the act of compression is attended with the evolution of heat; and if a main be pumped up quickly to 18 inches pressure, it will generally be found to lose 0·2 or 0·3 inch in the first half hour or so, afterward remaining stationary, provided it be tight, and no change is taking place in the height of the barometer. Conversely, if a main be pumped up to 20 inches pressure, and then sufficient air is allowed to escape to reduce the pressure to 18 inches, the inclosed air will have been cooled by expansion, and the (comparatively) hot sides of the main will gradually raise the pressure to 18·2 inches. It is thus evident that a loss of 0·2 inch for the last half hour after pumping up might be undetected by testing immediately, and thus a leaky main be passed as sound.

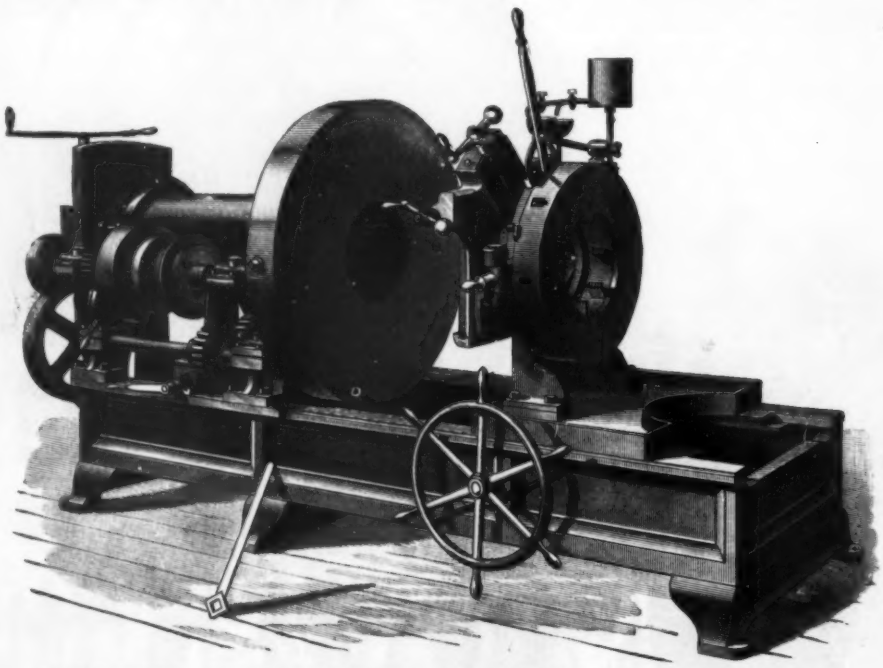
Minute leaks on the gauge are unimportant when testing long lengths of large main, since they rarely amount to one cubic foot per hour; and, as we have seen above, this in five miles of 30-inch main would be represented by about 0·03 inch on the gauge—quite an inappreciable amount. It is, however, far more satisfactory to have a tight gauge, and a piece of bent glass tube is by far the safest instrument. If the actual head of water be taken (not relying on a mark made on the gauge at the level of the water at the commencement of the test), it is immaterial if some of the water leaks away during the trial.

It is frequently asserted that wet weather is unfavorable for testing mains by compressed air, owing to the great condensation which takes place, whatever that may mean. My experience is in accordance with what theory would indicate, viz., that the dryness or dampness of the atmosphere is without the slightest effect on the results of the testing. Indeed, as wet weather is usually accompanied by a falling barometer, the reading of the gauge, when uncorrected for changes in atmospheric pressure, is generally favorable, and is often higher at the end of the test than it was at the beginning. Then, again, the porosity of the metal of which the pipes, and more especially the irregulars (bends, tees, siphons, etc.), are composed is said to be the cause of any leak which may be indicated. Now it is quite true that the bosses made by filling up the holes by which the core was supported are frequently unsound; and it is always advisable to put irregulars under pressure, and paint them over with soap and water, by which any leak is at once detected. But there is no such thing as general porosity. If a leak takes place, it is always at a part of the casting which is composed of drossy metal, or from some other defect equally apparent. Ordinary cast iron is practically impervious to gas or air. So also with regard to the magnitude of the leak or leaks. We may be quite sure that, to have an appreciable effect on such a large bulk of air as is contained in several miles of (say) 30-inch main, the escape must be considerable, and no slight bubbles found by applying soap and water to the union or other parts of the testing gauge will be sufficient to cause even one-twentieth inch fall per hour (after correction by the aneroid). The joint at fault will be found to have possibly an eighth or a quarter inch hole, from which the air will be issuing with sufficient noise to be heard two or three yards off. This is my own experience, and is fully borne out by theory, which indicates that one-twentieth inch fall is represented by a leak of about 16 cubic feet per hour, a very appreciable amount.

Finally, with reference to the degree of soundness practically attainable, I can only state that five miles of 30-inch main have been laid, on which there was absolutely no leak whatever, so far as the most careful and prolonged tests (five or six hours) could show; and that which has been done once can be done again. The great thing is to be reasonable in one's expectations; and the only way is to calculate for each testing to how many cubic feet per hour a certain fall of the gauge is equivalent. If this be not done, it is perfectly easy to condemn a 4-inch main because it is losing half a cubic foot per hour, or to pass as sound a 48-inch main which is leaking at the rate of hundreds or even thousands of cubic feet hourly.

IMPROVED PIPE CUTTING AND THREADING MACHINE.

THE accompanying engraving is a representation of a new and improved pipe cutting and threading machine, invented and manufactured by the Bignall & Keeler Manufacturing Company, 908 and 910 N. Main Street, St. Louis, Mo. The illustration represents their No. 12 machine, which cuts and threads pipe from 4" to 12". This machine possesses some specially new features. It can be operated with great ease, taking into account the nature of the work to be done. We were informed by Mr. Bignall (says the *Industrial World*) that a mere lad with the necessary appliances for handling the pipe can operate the machine. One of the special features of this machine is the ease and rapidity with which the dies can be changed, set, and adjusted. It has but one die block or holder, to which all the dies or chases are fitted. The dies only have to be changed, and this is accomplished without the removal of screw pin or bolt; and nothing heavier than the dies have to be handled. By means of a graduated scale, the dies are instantly regulated to their proper size. A device for adjusting the dies is the company's new patent die adjuster or lock. It has the elements of a compound lever, with screw-bar attached to a swivel stud on the outside of the movable cam-ring, and is so arranged that to open the dies all that is necessary is to raise the lever to a perpendicular position. This movement of the cam-ring is so gentle and uniform that no burrs are left on the thread, because the dies cut their way out. A child can do this when



IMPROVED PIPE CUTTING AND THREADING MACHINE.

in full cut. On the lever bar is a hand-nut for adjusting the dies, so nicely constructed that the dies may be set to the one-thousandth part of an inch; and this may be done, if desired, while the machine is cutting. This feature will be most readily appreciated by steam fitters, who have hitherto had so much trouble with different sized fittings. A large or small thread may be cut at will on these machines. It is often the case that a standard thread will not enter one end of a fitting, while in the other end of the same fitting the same pipe will be too loose for a steam joint. Every large steam fitter will readily understand this, and appreciate an improvement that enables him to overcome the difficulty. To close the dies all that is necessary is to pull the lever forward until it reaches the stop-stud, when the dies will be set to proper size and securely locked. To cut off pipe the die block is swung out of the way on its hinges, when the cutting off apparatus is in full view and easily operated. The steadying slides for holding the pipe while cutting off are steel faced and tempered. Being operated by a right and left screw, they are self-centering. All the chucks, both front and rear, are self-centering, requiring no rings or movable parts for griping or centering the pipe. There are no parts to become detached or misplaced or lost. The machine has twelve different speeds. The change of speed is easily effected by sliding one train of gears out of mash and another in. These are never detached from the machine, but are always in place and are moved by means of a lock-lever. It has a three-speeded cone, and with one change of gears six different speeds are secured. These speeds are all that are required for ordinary use, but in case of extraordinary power or heavy work, the back gear may be thrown into play, thus more than doubling its power, and making in all twelve different speeds. The manufacturers have also prepared a device for locking the door or die-block The small handle for pulling open the die-block is also utilized as a lock, thus saving a great amount of time as well as annoyance. When in a horizontal position it is merely used as a handle for pulling open the door, but when the door is closed, raising this handle locks the die-block for threading pipe. The whole mechanism is neat and substantial. The Bignall & Keeler Manufacturing Company entered one of these machines at the St. Louis Fair last fall, and were awarded a diploma and $100 premium, this being the highest award made to any machine on exhibition.

IMPROVED KNITTING MACHINE.

In the Dresden Victoria knitting machine, of which the accompanying is an illustration, the upper carriage, usually found in these classes of knitting machines, is superseded by an oblong carriage placed beneath, with parallel grooved bars, which run with greater ease and steadiness, thus enabling better work and more of it to be done in the same time. Durability is also increased, and when wear does take place

FIG. 1.

the parts can be readjusted with more facility. It is operated more directly than the older style of machines, being moved by a small handle on the outside and end of the machine. The cams (Fig. 2) are what are termed Cardigan, knitting a plain or Cardigan stitch with equal facility, but their up or downward movement is obtained by an improved arrangement which is direct in its action and not liable to get out of order. They can also be removed for cleaning or examination without taking out any other parts. For Cardigan knitting a new arrangement has also been introduced

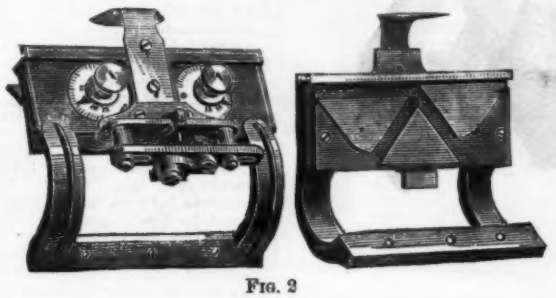


FIG. 2

by which the strain upon the wool is relieved, diminishing liability of breakage, particularly during racking for the production of zigzag work, when the strain is greatest. This is effected by the introduction of a small spring, which allows the cam to rise and fall with the recurrence of and relief from the strain. The racking handle is so constructed that in knitting stockings or plain circular work it can be placed below the machine out of the way of operations when not needed. In knitting the Cardigan stitch and others requiring the racking operation it can be brought upward, by which greater facility for movement is secured.

It will be plainly apparent to those familiar with this class of machines that the Victoria possesses several substantial improvements over the ordinary types. As yet only two or three have been put into the market, but it is confidently anticipated that the durability of this make, owing to the improvements we have pointed out, and the excellence of its construction in other respects, will be two to three times as great as those in ordinary use, owing to its greater firmness and steadiness in action. It has several accessories for special work, such as "striping" or "open side work," which can be more readily applied and their action rendered more reliable than before, as they greatly depend for certainty of execution upon regularity of movement and absence of vibration, which is secured in the new principle or arrangement of this machine. Every part is also made interchangeable, the importance of which will be evident to users, as it enables any breakages to be replaced without the trouble of fitting or the aid of a mechanic. This, we are informed, is a special feature in this machine, others only having particular parts made on this plan.

One of the attachments is a striping apparatus. This is so arranged that the yarn carrier is automatically released and carried round the yarn not in use, by which movement the yarn, thrown out of use for the moment, is left with its point of attachment inside the circular fabric. When the required number of rounds have been knit, by pulling a lever with the disengaged hand the yarn in action is carried out of operation and the other yarn again substituted. By this means variations are instantly effected according to the requirements of the pattern, all the effort needed from the operator to change the color of the yarns being to pull the lever.

Another attachment is the open-side apparatus. This arrangement can be attached to the cam slide by two screws. Its action is governed by the position of the stops at the four corners of the needle bed, which operate on the cam bed accordingly as they are set in or out, all the stops being in for circular work, whether the apparatus, is attached to the machine or not. When the latter is attached and the stops in, they act as in the ordinary machine, but when out they act upon the apparatus, which is so constructed that the cams are thrown out or into action only on the right hand side of the machine, leaving the fabric open on the left hand side, thus producing a flat web double the width of the machine. In knitting pants the legs are knit in the circular form and the body with the open side, the change being effected by the alteration of the stop as before stated.

These machines will be made in different sizes, from 8 in. to 19½ in. in the needle bed, and in gauges to suit various thicknesses of material from 4 needles to the inch up to 15, knitting from coarse Alloway yarn of 40 yards per oz. up to the finest cotton, silk, or other material of 500 yards per oz. A size particularly useful for large garments is 14⅝ in. bed, on which all sizes of ribbed stocking legs can be produced in every variety of rib, such as 2×1, 2×2, 2×3, 2×4, or any other combination. Garments in plain and rib stitches in connection with the open side attachment, consisting of Jersey suits, football suits, trousers, and Jerseys, can easily be made; men's pants in two parts, under vests for ladies and gentlemen in plain or ribbed stitches; in Cardigan stitch jackets and vests, boys' suits, wraps, shawls, ladies' skirts, etc. In the short or 8in. bed, stockings, plain and ribbed, scarfs, mitts, gloves, leggings in plain and fancy stitches, are within range of its capability. Ladies' garments and wide articles can also be made by knitting them in sections. In the longer bed machines, by the addition of a second set of cams, two small articles—such as stockings or similar things—can be knit at one time. Also, by the use of an adjustable handle, the traverse of the cam carrier can be limited to a small range on the large machines, and small articles be produced with a facility equal to that obtained with machines having a small bed.

A recent invention is the Jacquard machine, by which the work can be almost infinitely varied in the stitch with the greatest ease, without taking the work off the needles. The operator can knit a plain or fancy web of any description, and at any moment ornament it by the introduction of an entire change. From the latter the preceding style can be renewed, or any further change be introduced. Fig. 3 shows this special form of the knitting machine, along with illustrations, Figs. 3a and 3b, of several fancy stitches, as well as such representations can be conveyed by this means. These machines are so constructed that the needles are worked by a new and original arrangement. The needles work in gooves, in opposite needle-beds, but below the needle-bed is another steel-bed with corresponding grooves, in which work the lifting pins; by these pins the needles are raised for the formation of loops. This lower bed can be moved so that any given pin can be brought to operate upon five different needles by moving the handle on the left hand of the machine to left or right.

The above machines, along with many other makes, emanate from the establishment of Messrs. Lane and Timaeus, Dresden, Saxony.—*Textile Manufacturer.*

FIG. 3a.

FIG. 3.

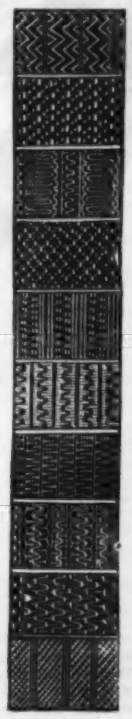


FIG. 3b.

HOW TO TAKE ARTISTIC LANDSCAPES.

In composing a landscape, or, more correctly, in making selection of the point of view from which to photograph a landscape, there are certain canons of art with which the aspirant after artistic fame must become acquainted. The lack of this knowledge has in innumerable instances laid the photographer open to the undisguised contempt of the cultured artist, who, having been well grounded in the rules of his profession, seems unable to tolerate their breach by his, in this respect, less favored brethren of the camera.

Just observe in what an unceremonious manner a few artists will pick to pieces an otherwise good example of portrait photography, when they discover that the unfortunate camera portraitist has, in his ignorance of the requirements of correct drawing and perspective, placed the horizon of his scenic background on a level with or below the waist, and in some instances even the hips and knees of his subject. They might tolerate ungrammatically expressed utterances from one who could otherwise teach them something, seeing that such offenses against correct diction die away in the air, but to perpetuate in a photograph, which is sup-

posed to be nothing if not truthful, such flagrant violations of the code of art—such was not to be thought of for a moment. Let it never be forgotten that photography is an art as well as a science, and that the taking of merely sharp and well rendered images of external nature is not all. What is required are good photographs that are also good pictures—good in the artistic or æsthetic as well as in the manipulative or mechanical sense.

THE CENTAUR.—BRONZE DESIGN FOR A FOUNTAIN.

It is perhaps in the posing and arrangement of family groups that the most hideous caricatures of art are to be found. Who has not seen and smiled at the time honored pose adopted by the inartistic photographer who in the family group places the father and mother in the center holding each other by the hand, while the children are arranged pyramidally on each side like a row of nine-pins. This, however, concerns the professional; it is to the amateur, and especially to the amateur landscapist of limited experience, we now address a few words.

Reference has been made in the foregoing to the height of the horizon in a background with setters in front. The height or position of the horizon in a simple landscape photograph is a matter of importance. Let the works of the most eminent landscape painters be analyzed, and it will be found that the horizon is never in the middle of the picture but almost invariably a little below it. While many high class works which we have examined have the sky and land in the proportion of two parts of the former to one of the latter, a still larger number have the horizon rather higher up, or as two to five. It perhaps may not seem quite fair to photographers to institute a comparison in this respect between their skies and that of the painter, who brings to his aid the powerful allies of color and cloud forms, in which he allows his imagination to run riot; but even here the photographer who is possessed of a set of cloud negatives can always successfully hold his own. It may be laid down as a safe rule to never allow the horizon to be in the center of the picture, but always either above or below it. For the ordinary class of landscape it will, as we have said, be better to be a little below the middle; still there are many circumstances under which it may be considerably higher.

All straight, geometrical disposition of lines in a subject should be avoided. In photographing a straight road, a canal, or a railroad, the camera ought never to be placed in or above the center of such road, unless there are some special circumstances apart from art requirements which demand its being done. A gate, a bridge, or in short anything in which there is squareness or parallelism of lines, invariably looks better if taken obliquely than "square on" or direct. In taking an avenue of trees a central position should be avoided, and that a little to one side selected.

Monotony or repetition of forms, especially in a foreground, should give way to variety both in object and direction. In printing in clouds avoid the bad taste sometimes displayed in making them adapt themselves to the outline of the mountains or trees in a landscape. Avoid also having as a foreground an even, flat grass field. If it be quite impossible to get a few sheep or cattle driven within the range of the camera to impart variety to such a foreground, then let the camera be lowered as much as possible so as to have it foreshortened, thus reducing the dimensions of its dreary monotony.

By noting some of the obvious rules of art, of a few of which a faint outline has been here given, the photographer will soon come to insensibly place his camera in the position best adapted for securing an artistic transcript of any scene in nature.—*Photo. Times.*

STELLAR PHOTOGRAPHY AT HARVARD.

AT the meeting of the Astronomcal Society which was held on June 8 last, Prof. Pickering, of Harvard College Observatory, so well known for his stellar observations, and who is a Foreign Associate of the Society, attended and gave an interesting account of the work which has been done during the past few years at his observatory.

Some few years ago Prof. Pickering took up the work of determining the intensity of the light of the principal stars by eye observation, without taking the question of color into consideration, work which has been already dwelt upon in this journal. For this purpose he used a photometer, completing his observations, which number some 90,000, about a year ago, and a large part of his results are already in print. The published results of the more important investigators of star magnitudes, from the time of Almagest and Lufl, have also been reduced. Sir W. Herschel's observations, which appeared almost a century ago in the *Philosophical Transactions*, have likewise been taken in hand at Harvard Observatory and completely discussed. Sir John Herschel's works, the "Uranometria Nova," the "Durchmusterung," as well as many other works in the same field, have also been made use of in preparing the Harvard Catalogue, which therefore shows those cases in which the photometric observations carried out by Prof. Pickering differ from the results obtained by other observers, when their observations are reduced to the same system. These eye observations of stars having been completed, Prof. Pickering, in conjunction with his brother, Mr. W. H. Pickering, has taken up stellar photography from the same point of view. By this means a comparison is obtained between the brightness of the star as seen by the eye and its brightness as determined by its greater or less action upon the photographic plate; and by a comparison of photographs taken on different nights any variation in brightness may be defected; while the exact positions of stars may of course be more accurately and permanently recorded than by eye observations. Mr. A. A. Common recently, by taking photographs of the nebula in Orion on different nights and comparing them, has thus been able to detect a probable variation in one of the stars in the nebula, and in 1858 Professor George P. Bond, by measuring the diameters of stars in photographs, was able to determine the relative brightness of the two stars which form the double ζ Ursæ Majoris.

But the work at Harvard University was to do more than this. The stars which Prof. Bond examined were close together. Prof. Pickering wished to compare stars far removed from each other. For this purpose the ordinary method of stellar photography, by which photographs are taken at the foci of large telescopes, would not suffice. These photographs only comprise a small region of but one or two degrees in diameter. A different method was therefore employed in the Harvard observations. A wholly different form to the ordinary equatorial telescope was used. It is not unusual to construct photographic cameras to take pictures of buildings which subtend an angle of 60° or even 90°. But when applied to the stars, however, the images at the edges are very poor, and only very small apertures can be used. It has, however, been found that some of the best lenses for pictures can be obtained covering a circle of 20° diameter without serious distortion, and at the same time large apertures can be used, thus reducing the time of exposure. In order to still further this work, Mr. W. H. Pickering investigated the sensitiveness of various photographic plates, and obtained some so sensitive that stars of the fifth and sixth magnitude have been photographed without using clockwork, they forming dots or making lines, as their images pass across the photographic plate, the length of these lines depending of course upon the time during which the plate is exposed. If the plate be exposed during ten seconds a distinct dot is obtained, while an exposure of thirty seconds causes a short line to be formed. The plates used at Harvard Observatory are six by eight inches. They are divided into six equal parts, each part being in turn exposed. By this means six regions of the heavens, each about 15° square, may be photographed on one plate; and by a variation in the dot and line system employed, sometimes taking the dot and sometimes the line first, three pictures may be taken on a single division of one of the plates without giving rise to any confusion. Instead of simply six, therefore, eighteen photographs are taken on one of these plates, so that on a single plate a portion of the heavens of more than three hours right ascension, and extending from 30° S. to 60° N., may be included. Since each portion of the plate covers a region of about 15°, the camera mounting has a series of notches or stops, by which it may be instantly moved through that amount either of right ascension or declination.

When photographing, the following is the exact method employed. The first exposure takes the region between 20°

and 15° south declination, and between one hour and a half and half an hour west of the meridian. First the plate is exposed for ten seconds, and each star records itself by a dot. The plate is then covered for ten seconds; next it is exposed for a period of thirty seconds, and each star makes a line on the plate. By means of the clamping arrangement to which we have referred the plate is then moved through one hour in right ascension. This takes up the remaining few seconds of the minute, so that the taking of the next photograph begins with the first second of another minute. The camera is then on the meridian. The same part of the plate is again exposed, and in order to distinguish this series of stars from those first photographed, this time the plate is exposed first during thirty seconds, and then during ten, so that the result is a line followed by a dot. This gives the second series. But the same portion of the plate may be again used. The remaining ten seconds of the second minute, like those of the first, are spent in moving the camera through another hour of right ascension. Then a fresh exposure is made for thirty seconds, a line simply being obtained without a dot, and this completes the series. The first class of images is in dots and lines, the second in lines and dots, the third is recognized by the presence of lines alone. The thirty seconds which remain of the third minute are employed in exposing a second portion of the plate, and changing the position of the camera, which now takes in the region from 15° S. to the equator. The same process is then gone through again, three exposures as before being made in three different positions of right ascension. By continuing this process, taking three photographs on each of the six portions into which the plate is divided, the whole region included between the declinations of —30° and + 60°, and between three hours of right ascension, 1½ hours on each side of the meridian, being one-eighth of the whole heavens, excluding the circumpolar stars, will be photographed on one plate, the whole operation occupying but eighteen minutes. With regard to those stars in the vinicity of the pole, some other method will have to be adopted. Thus much for one branch of the work—and an important branch—carried on at Harvard Observatory.

Another portion of their work consists in the preparation of a photographic map of the entire heavens. The method just described, in which clockwork is dispensed with, only enables those stars whose magnitude is not less than five or six to be photographed, and stars of a less magnitude than this must of course be included in a map of the heavens. The camera in this work, therefore, is driven by clockwork. By this means stars of the eighth magnitude record their images on the photographic plate, and as many as 200 are visible in the paper print within a circle of 5° in diameter. A photograph taken in this way of a portion of the constellation of Orion, besides showing the three stars of the Belt and the Sword-handle, gives an interesting picture of the nebula.

With reference to the question of the colors of stars it is interesting to note the faintness of α Orionis in the photographs. To the eye its brilliancy is almost as great as that of β, while in the photograph it is not more prominent than λ. The reason is to be found in the color of α. It is a red star, and consequently makes but little impression on the photographic plate.

Again, in the constellation Cetus the three stars which are brightest to the eye are α, γ, and δ. A, which is the brightest of the three, has close to it a very faint companion, scarcely visible to the naked eye, its magnitude being given as 6·3, while that of α is 2·7. This is the appearance of this part of that constellation as seen by the eye. A photograph of this region was taken at Harvard with the result that the small star is seen in the photograph nearly as bright as α, it being only three-tenths of a magnitude less. The color of these stars again explains this, α being of a reddish tint, while the small star is of a deep blue color, and being so the rays which flow from it have a greater influence on the photographic plate. A comparison of the number of stars seen in the photograph of Orion with the number in the photometric catalogue further illustrates this effect of color. In that part of this constellation included between 5° north and 5° south declination, and 75° to 90° of right ascension, sixteen stars were common to photograph and catalogue; a like number, being either too small in magnitude or too red in color, although catalogued, remain unrecorded on the photographic plate; while five others seen in the photograph are not given in the catalogue. A reduction has been made of the results given by the plates of different makers, with the view of ascertaining the value of the deviation. In two of such plates the average deviation was 0·21 of a magnitude, and in two measurements of the same plate it was found to be 0·07 of a magnitude.

It is obvious from this account of the work at Harvard that star photography is entering into a new phase, and one which will entirely replace the present system of eye observations, for the reason that, while the eye is so variable, photographic plates may now be obtained, doing their work with almost definite wave-lengths of light. The constant record of the plate must in time therefore be preferred to observation by the variable eye. At the same time as photography advances, if it be considered necessary to obtain photographic star maps to record the observations of the average eye, there will be no difficulty in this being done.—*Nature.*

INSTITUTE OF PAINTERS IN WATER COLORS.

THIS building, erected on a site facing Sackville Street, and adjoining St. James' Churchyard, and Vestry Hall, Piccadilly, has been designed by Mr. Edward Robert Robson, F.S.A., architect, for the exhibitions of the Royal Institute of Painters in Water Colors, and the galleries for this purpose are arranged as indicated by the plan which we give. Below these is a hall for concerts and meetings, while, on the ground floor are shops and business premises. The public entrances to the hall are at either end, and the picture gallery entrance is in the center of the facade. This is entirely executed in Portland stone. Our drawing was exhibited at the Royal Academy this year.—*Building News.*

WHAT DRAINAGE DOES.

THE late John H. Klippart condenses the advantages of tile drainage under the following twelve heads:

1. The drainage removes stagnant waters from the surface.
2. It removes surplus water from under the surface.
3. It lengthens the seasons.
4. It deepens the soil.
5. It warms the soil.
6. It equalizes the temperature of the soil during the season of growth.
7. It carries down soluble substances to the roots of plants.
8. It prevents "heaving out" or "freezing out."
9. It prevents injury from drought.
10. It improves the quality and quantity of the crop.
11. It increases the effects of manures.
12. It prevents rust in wheat and rot in potatoes.

PROGRESS IN TELEPHONY.

A NEW advance has been made by this remarkable instrument. Mr. Van Rysselberghe has just devised a new system of telephone differing very sensibly from all those known. The arrangement and details of the apparatus have not as yet been made known to us, but the following result of some experiments that have just been made with it are communicated to *La Lumière Electrique* by Mr. F. Geraldy:

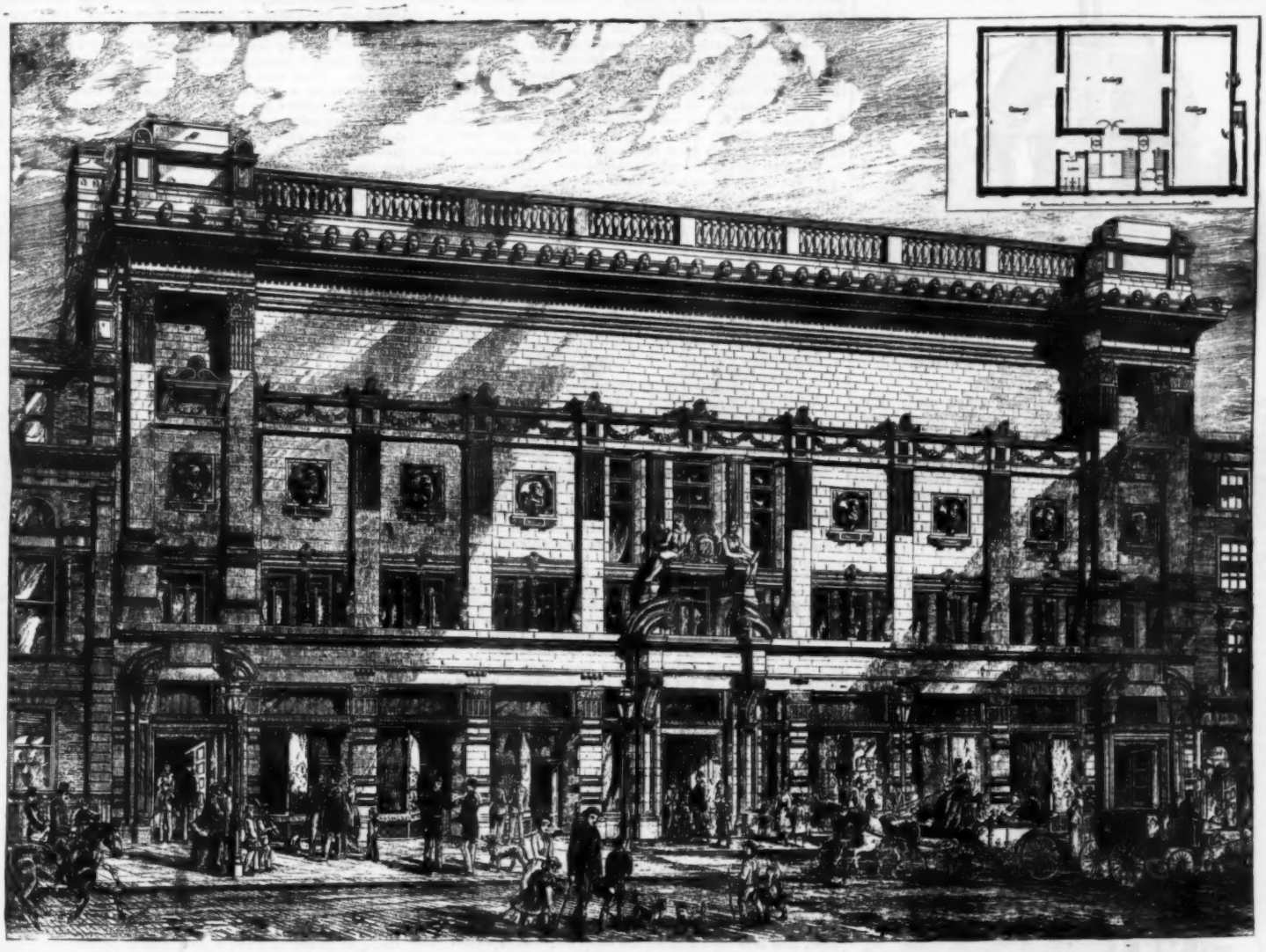
The system had first been put in operation on the line from Brussels to Ostend, but its inventor, desiring to experiment with it to a greater distance, has just tried it between Paris and Brussels. . . .

Through the kindness of Mr. Van Rysselberghe I was permitted to be present at the experiments on the 17th of May. I ascertained that conversation between Paris and Brussels was easy, that articulation was clear, and that it was not necessary to speak loud, but only in a clear and distinct voice—that, however, being required by the telephone.

Such a result, were it the only one obtained, would doubtless not be absolutely new, for our readers will recall the experiments at great distances with the Herz system, that we have had occasion to describe. Various attempts of this nature have been made with more or less success, but we may say that that of Mr. Van Rysselberghe has succeeded better than any that has been tried. But that is only one feature of the system.

The inventor has bestowed his attention on a means of overcoming that terrible enemy of the telephone, induction. On this subject, I recall anew the studies made by Mr. Herz, on the means of employing the condenser in telephone lines as a preserver as well as receiver. The process employed by Mr. Van Rysselberghe has some points of contact with those experiments, while very sensibly differing from them. Mr. Van Rysselberghe, by an ingenious detour, instead of guarding against induction on the telephone line where it produces its injurious action, endeavors to prevent its occurrence by suppressing it in the lines on which it is produced. To this point we shall hereafter return more in detail. He has experimented, however, only imperfectly at Paris, where there was no time during these first experiments, designed only as a study, to provide all the prejudicial lines with preservative apparatus. The partial experiments have, however, sufficed to prove the efficacy of the process on telegraph lines.

From the combination of these two measures (I mean the improved telephone, and induction overcome), Mr. Van Rysselberghe has derived an unexpected and striking result; for he has succeeded in putting upon the same line, and in causing to operate at the same time, a Morse telegraphic apparatus and a telephone. I have seen these apparatus work at the same time, and it is beyond dispute that they do not perceptibly interfere with one another, the double transmission being effected without any difficulty.



THE GALLERIES OF THE INSTITUTE OF PAINTERS IN WATER COLORS, PICADILLY, LONDON.

At the first trial, which took place on the 16th, there were transmitted simultaneously to Brussels two dispatches. The telephone dictated one (which it is unnecessary to reproduce here), while the telegraph was registering another (and entirely different one). These two dispatches were at once sent to their address. It should be remarked that they passed at ten minutes past eight in the morning, that is to say, after the work of the office had been resumed, and when inductive actions were already very energetic. We shall study more at leisure the processes employed by Mr. Van Rysselberghe, but it has seemed to us well to call attention to these beautiful experiments at once after their occurrence.

MORIN'S SOLENOID CANDLE.*

WHEN, in 1876, Mr. Jablochkoff had invented his candle, the enthusiasm excited by this new light was simply due to its simplicity, this contrasting so strongly with the compli-

FIG. 1.—MORIN'S ELECTRIC CANDLE.

cation of the regulators that were then being used. But, while the candle showed its good qualities on being used, it soon also exhibited its defects and desiderata. Among the reproaches brought against it, the one that seemed to be the gravest was the impossibility of relighting it after it had been extinguished. Let us say at once that although this drawback still exists in the candles that are at present employed, the same importance is no longer attached to it. But, at the epoch of which we speak, the defect appeared to be a capital one, and so endeavors were made in various ways to remedy it.

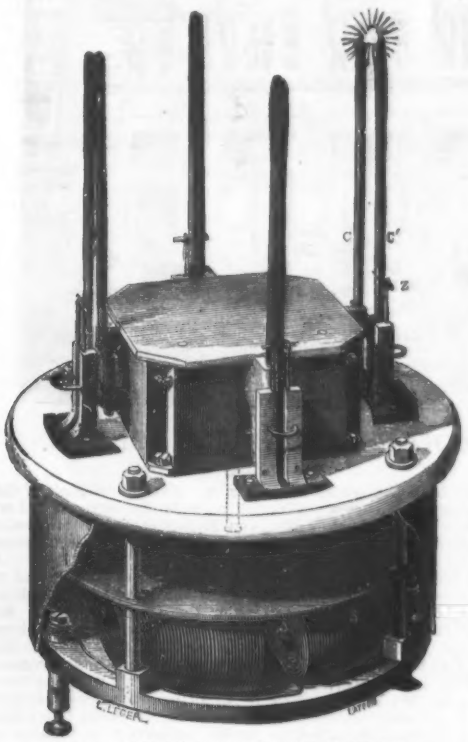


FIG. 2.—MORIN'S ELECTRIC CANDLE.

As long ago as 1878, Mr. H. Wilde invented a candle that overcame the difficulty; and after him succeeded Messrs. Jamin & Debrun, whose apparatus were scarcely anything else than more or less distant relatives of that of Wilde. In the Wilde burner one of the carbons remains stationary while the other is movable and connected by a lever with the armature of an electro-magnet. When not in operation, a counterpoise causes the point of the movable carbon to rest upon that of the fixed one, but, as soon as a current passes, the electro-magnet establishes a parallelism again between the two carbons, and the arc bursts forth between their two extremities. This very simple arrangement has not, however, realized all the expectations that were had of it, not as regards relighting, which is always effected well enough, but on account of the numerous oscillations that the light exhibits, and which are due in part to the action of the electro-magnet. Moreover, when one candle was consumed, a break intervened before the current could be passed into the following.

* From *La Lumiere Electrique*.

These are disadvantages that Mr. Morin, engineer of the Parisian Electric Lighting Company, has sought to overcome by the new arrangement that we shall now describe.

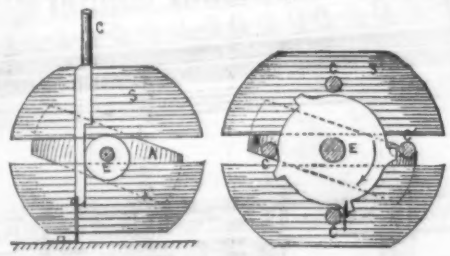
In these new apparatus, Mr. Morin has substituted for the electro-magnet a solenoid whose action is, it is true, less energetic, but which acts at a much greater distance; so that, instead of the violent and instantaneous action of the electro, we have a progressive one which avoids the metallic vibration produced in the first case, the noise from which was often louder than that from the arc itself.

Figs. 1 and 3 represent a single candle chandelier. As may be seen, the solenoid, S, is flattened and has nearly the form of a galvanometric helix, only, instead of being rectangular, the internal cavity is circular, and it is in this that is placed a strip of soft iron, A, movable around a horizontal axis. When the lamp is not in operation, the strip, A, is slightly inclined with respect to the wire of the soenoid, but, when the current is passing, it tends to place itself cross-wise with it by revolving upon its axis. It is this rotation that is utilized for obtaining the separation of the carbons. To this end, a snail-shaped eccentric, placed upon the axis of the strip, A, and participating in its motion, draws back the movable carbon, C, to produce the arc, and holds it all the time during which the current is passing. But, when the latter ceases, a spring draws the strip, A, back to its starting-point, and the carbons, coming in contact again, are thus made ready for a new lighting.

On increasing the dimensions of the apparatus slightly the solenoid has been given a much greater power, and it has become possible to place four burners in the same apparatus, thus permitting of obtaining a lighting of long duration without there being any need of renewing the carbons.

In this apparatus, of which Fig. 4 is a diagram, and Fig. 3 a general view, the solenoid, S, is placed horizontally, and the axis of the iron strip, A, is vertical and carries a cam-wheel that acts upon four movable carbon-carriers, just as the snail acts in the simple chandelier. The cams, moreover, are so placed as to act successively.

In this arrangement, the lighting is effected as in the former one. When the current passes, the solenoid iron, which was held in a certain position by a spring, makes a move-



FIGS. 3 AND 4.

ment in a direction transverse to that of the wire until a cam has reached the movable carbon-carrier of the first candle and produced an arc. When the current ceases, the solenoid iron is drawn back to its initial position by a spring, and the carbons again come in contact.

In order to obtain a successive and automatic lighting of the different candles, the fixed carbons are held by a small bit of zinc wire, Z, which burns as soon as the arc has, through wear, reached a definite height. Then the fixed carbon, being no longer held, falls from its support, and the arc is again broken before it has been able to impair the apparatus. But, as the current is again closed by the other candles that are in contact, the iron strip, A, revolves until the second cam brings about a lighting of the second candle, and so on. The passage from one candle to another is effected very rapidly, and so much so that it would scarcely be possible to note the moment when it occurs.

In a study of this new light, Mr. Morin has observed a few phenomena resulting from the action of the solenoid upon the voltaic arc. Thus, in a chandelier in which the four candles were symmetrically arranged around the axis of the strip, A, two of them that were diametrically opposite, and situated above the free space comprised between the two halves of the solenoid, were not at all influenced; in the third, which was situated over the middle of one-half of the solenoid, the arc was slightly repulsed toward the extremity of the carbons, as in Jamin's apparatus; and, finally, in the fourth, the arc was driven toward the base, that is to say, against the supports, which would have been destroyed in a few instants.

These differences of action, which may be readily understood on considering the direction of the current in the arc and in the nearest portions of the solenoid, constituted a very grave defect, which Mr. Morin has remedied by removing the solenoid as far away as possible, and by interposing a strip of iron plate, which, according to him, gives a proof of the reality of magnetic screens.

For measuring the work absorbed by these candles, the inventor makes use of a continuously indicating dynamometric pulley, which he has constructed after the principle of his dynamometer. He finds from this that—

3	candles	absorb	3·80 H.P.
4	"	"	4·16 "
5	"	"	5·40 "

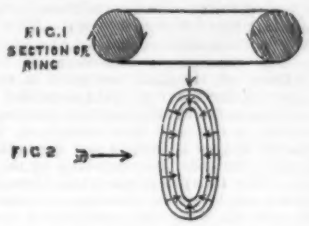
WOODEN TAPS.

ALL wooden taps used for chemical purposes may be well preserved by plunging them into a bath of pure paraffin heated to 110° or 120° C. This temperature must be kept up as long as we perceive any air bubbles arising from the wood. The bath is then, and then only, allowed to cool gradually, and the taps are taken out just as the paraffin is about to solidify. The excess of paraffin which still adheres to the outside is rapidly wiped off with a cloth, and the tap is finally subjected to an energetic friction with the same cloth. After this treatment an ordinary wooden tap, which, generally speaking, is soon unfit for use, may be preserved for a considerable length of time, and will be found to resist the corrosive action of dilute acids perfectly. Many other objects in daily use in the pharmaceutical laboratory may be advantageously treated in the same manner, and so preserved for a long time from the effects of corrosive liquids, damp, or oxidation.—*Monthly Magazine.*

ON CERTAIN PHENOMENA MANIFESTED BY LIQUID VORTEX RINGS.

By MR. T. HART, ASSOC. R.S.M.

THE following are a few beautiful, yet very simple, experiments on vortex rings made by the author in conjunction with Mr. L. Reed, F.C.S. Before describing them, a few remarks may be made as to the nature of these rings. These rings enable one mass of fluid to travel through another mass of fluid with the least possible disturbance of the latter. The motion of the rings is general and internal, and the internal motion is shown in Figs. 1 and 2, the directions in which the



ring itself is traveling and the directions of its moving particles being indicated by arrows.

The formation of vortex rings is largely influenced both by the cohesion of the fluid through which they are themselves passing, and also by the cohesive forces exercised between the molecules of the rings themselves. They may be observed escaping from the chimneys of portable steam engines; on igniting bubbles of phosphureted hydrogen, and issuing from tobacco-pipes, and from the mouths of some smokers. They may also be produced from perforated flexible boxes in a way too well known to need description. Smoke rings have been very fully investigated by Professor Osborn Reynolds, and by some German physicists, who have dealt fully with these phenomena. The author's experiments have taken a somewhat different direction, and he has employed liquids instead of smoke in his investigations, the results of which will be found interesting.

Perfectly formed vortex rings produced by simply dropping one liquid into another.—(1) In order to obtain the most perfect ring we may take a solution of ferric chloride, and place a small portion of it in a burette, so that a drop can be produced at will by regulating the stop cock. Beneath the burette place a large beaker containing a dilute solution of po-

FIG. 3

SMALL RING TRAVELLING WITH HIGH VELOCITY

FIG. 4

SMALL RING SPREAD OUT ON TRAVELLING EURTHER

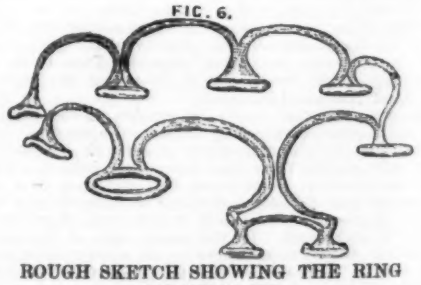
tassic sulphocyanide (KCNS), such that a beautiful blood-red color is developed in it by a drop of the ferric chloride. By then approaching the nozzle of the burette so close to the solution that the drop formed will just not touch the liquid, and allowing a drop to form and fall, a beautiful blood-red ring will sink gently through the solution, undulating to and fro in the liquid, and then splitting off into a number of smaller rings, which dart off with increased velocity; and these again split up, generally into two rings, forming, as it were, secondary, tertiary, and quaternary

FIG. 5.

RING JUST ABOUT TO BREAK UP.

rings, as shown in Figs. 3, 4, 5, and 6. On trying the experiment again with other liquids, the author obtained similar and equally beautiful results: (1) By dropping bichromate of potash in weak solution into water, or preferably into ferrous chloride, when the color disappears, rendering the lower solution green. (2) By dropping a solution of cupramine—obtained by treating sulphate of copper with a large

FIG. 6.



ROUGH SKETCH SHOWING THE RING BREAKING UP.

excess of ammonia—into water, when a beautiful deep blue ring, behaving as before, is obtained. (3) Red ink, aniline dye colored liquids, and other colored liquids behave similarly. The flatter the surface, the larger the drop; hence, by the use of a bulb, may be obtained very large and very perfect rings in this way. The author attempts to account for the splitting up of the rings in the following way: Let Fig. 7 represent the section of a large ring; the arrows show the direction of motion of the molecules. When the ring

has sunk for some distance, the ring begins gently to undulate, one portion of the ring during its undulation coming lower than the other parts. The motion of the internal molecules of the ring having practically ceased, the liquid matter of the ring being denser than the surrounding liquid, its tendency is to sink per force of gravity, and to do so this lower part assumes the form of a vortex ring, produced by the friction against the sides of the sphere of liquid, and also because this form is the best adapted for traveling; the rings thus made dart aside from the old, destroyed, but

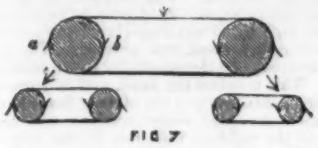
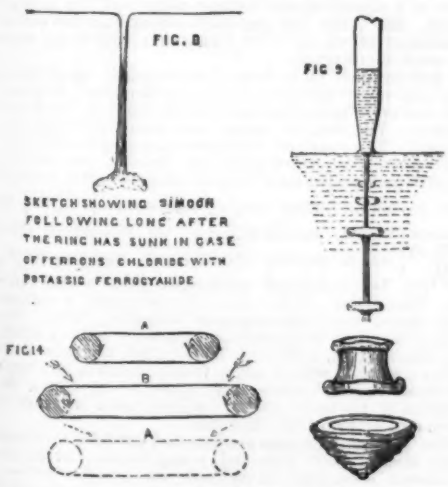


FIG 7

main ring, possibly deflected by the cone of downward rushing liquid spoken of elsewhere. For the splitting up of a ring some force, such as gravity, must act on the ring after its several molecules have come to a standstill.

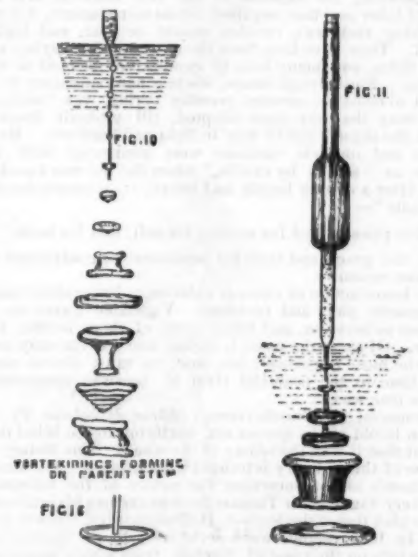
(2) *A series of vortex rings produced by allowing one liquid to diffuse into another in a thin liquid stream.*—By taking similar solutions to the above, but treating them in a different manner, we obtain remarkable results. In one instance the author took a large pipette—one of 50 c. c. capacity—and filled it partially with the liquid in question; the deep blue solution of cupramine gave the most perfect results. The upper end of the pipette was then completely closed by a stopper, and the nozzle of the pipette approached so as just to touch the liquid below, which was, when using cupramine, water; and behind which a sheet of note paper rendered observation clearer. The beauty of the phenomenon which then occurred passes far beyond the author's powers of description, and can only be realized by actual experiment. What occurred in the first place was what might be expected, for the higher solution gently diffused in a steady downward stream into the lower, while a stream of the lower colorless solution was seen making its way up the pipette. A series of vortex rings forming were then noticed, as it were, on the parent stem, first appearing as mere knobs or knots on the liquid string, then, by their increased powers of motion, darting off through the liquid, only to gradually diminish in rate of motion until other rings, chasing them, passed through them, giving an appearance somewhat resembling a "top hat," or a sea anemone, by drawing out, as shown in Fig. 10. It would seem that any disturbance of the liquid in the pipette will give rise to an increase in the number and size of these rings, for some precipitate happening to fall into the tube during one of the experiments caused an increase in size and number of the rings. Also the slightest variation in temperature of the inclosed air seems to cause a similar result, thickening the sectional area of the stream if the bulb is very slightly warmed, and increasing the number of rings. So that by keeping a stream of this sort uninfluenced by external forces, the slightest variations in the temperature of the medium surrounding the bulb could be noticed with ease, especially if the bulb be filled with ammonia gas, whose tension varies so readily, as occurs on using cupramine solution. So sensitive is the fluid that the approach of the warm hand within six inches of the pipette will modify the results, and we have thus an extremely delicate indicator of very minute changes of temperature. The phenomena may possibly yet be utilized for thermometric purposes.

(3) *Dropping various liquids into one another and observing the effect on the rings.*—Having obtained such perfect rings so simply and so readily, the author extended the idea by dropping all kinds of liquids into one another, obtaining beautiful results. (*a*) He took ferrous chloride and dropped it into a weak solution of potassic ferricyanide. No blue color was formed at first, owing to the excess of ferrous chloride; soon by continued observation he saw, after a short time had elapsed, a "simoom" of blue color rush ing down after the invisible ring, owing no doubt to the potassic ferricyanide being in excess, and showing what a powerful current follows in the wake of a ring. By gently rotating the lower liquid, the simoom or eddy always follows



the motion as if it were very rigidly part of the liquid (see Fig. 8), and the fact that the latter of two rings which follow one another in very rapid succession is frequently destroyed, is borne out by this experiment. The experiment may be varied, not only by taking solutions of different materials, but the author succeeded in obtaining the phenomena of the passing and repassing vortex rings with greater rapidity by using a denser solution in the case of the upper liquid, as shown by Figs. 9, 10, and 11. No adequate idea can be given of the effect created in the mind by seeing these rings form one sooner than the other, those later formed making up for lost time by rushing after the first-formed rings, sucked into the center of these, no doubt, by the vortex action of the first ring, thus hurrying on those nearly spent by force of traveling, and the drawn-out rings becoming rapidly collapsed, when a third and faster ring hastens all into one large ring, which, in its turn, is only to be acted on by others following in its wake. The rings when first formed have a mushroom-like shape, and it would require the delicate touch of an experienced artist to note on paper the waving, gentle curves by which the opera-hat-like appearances are bounded, when obtained by the passage of one ring through the other. The whole motion when watched for some time reminds one more or less of eddies in a river or pool, especially when the rings follow one another in rapid succession when the solution is dense.

Sometimes the rings form a large number of fantastic shapes, and if the solution is strong enough these are bounded by wavy, oily-looking hues, due no doubt to the higher refracting power of the denser liquid and produced in the same way as lines in striæ. These shapes sometimes resemble that of a cup and saucer, and the author had the good fortune to see the rings so rapidly succeed one another, that a cup-and-saucer shape has occurred inside the ghost of an opera hat. They resemble sometimes the shapes obtained by the rotation of curved wires in the hollow of the cylindrical projection of a chameleon top. He had at times been able to watch a very small quantity of the solution continue these phenomena for hours, though the action soon becomes less energetic. He believes that good authorities have stated that these rings possess great powers of elasticity when brought into contact, and never actually destroy one another. He thinks that these experiments tend to prove this, for though the rings draw one another out and alter their appearance, they do not lose the circular form. In fact, on analyzing their motion he finds, as shown in our annexed sketch, that taking sections of two rings, one of which is



about to pass through the other, the tendency is for the passing ring to destroy the internal motion of the lower of the two rings for a moment at least, and having done so, its own internal motion slightly diminishes, to suck the ring it has just passed through into its own center, and this is no mere theorizing, for he has actually seen it happen. How far down into the liquid this phenomenon may continue to take place he has unfortunately not had the power of judging, for none of the vessels which he has been able to command, though deep, have been sufficiently deep to show when the action ceases.

(*b*) Strong ferric chloride dropped into strong potassic ferrocyanide gives a deep blue solid ring, after having moved as a colored semi-solid one for some distance—semi-solid owing to the excess of solid particles in the liquid—and occasionally a deep Prussian blue tube will form after the ring has sunk, and grow just as if it were alive, where the simoom in the previous experiment occurred. (*c*) Cupric sulphate in potassic ferrocyanide gives a brown ring. (*d*) By dropping strong hydrochloric acid into a strong solution of sodic carbonate, the ring sinks unchanged as acid to a certain point, when chemical reaction takes place, and the whole appears to rush bodily upward by the formation of a quantity of escaping bubbles, showing possibly that chemical reaction does not take place while cohesion is acting. (*e*) If we take a liquid made of dense acid below—hydrochloric acid rendered dense by common salt—with less dense sodic hydrate above, then drop a solution of litmus into the liquid, the blue ring sinks through the soda then resting, destroyed, on the denser liquid, giving rise to a series of minute red rings sinking very slowly through the acid. A very similar result

FIG. 15.

Mushroom-shaped appearance produced by allowing a stream of liquid lighter than the surrounding to issue from below the denser liquid.

was obtained by throwing a drop of red ink in the spheroidal state from a red hot platinum crucible on to water; the fluid as it began to cool sank gently as a series of very beautiful red rings, like stars from a burst rocket, although while still hot it rested or floated inert on the surface. (*f*) The author was enabled to obtain vortex rings reflected by allowing them to strike the bottom of a basin, when they rose to the surface as new rings. (*g*) Upward rings may be obtained either by dropping a light colored solution into a denser one, when the liquid first sinks as a ring, then, as it were, changes its mind, reverses its motion, and comes up again as a ring; or (2) the author obtained them by allowing a lighter liquid to escape from the bottom of a denser one from an upturned jet, when a peculiar mushroom-shaped appearance rises to the top, the lower part being the ring, and seen as such on looking down from above—see Fig. 15. (4) These last show the effects of density and cohesion. Mercury dropped into treacle sinks as a sphere; oil allowed to escape beneath the surface of water rises as a flattened sphere. Treacle dropped into water sinks as a bulb, leaving a trail behind it—mixed with water, he obtained good vortex rings with treacle. Gum in strong solution dropped into water gives an attempt at a ring, as in Fig. 16.

The author tried bichromate of potash solutions of different strengths, and found that with three solutions—1 strong, 2 middle, 3 weak—the middle solution caused a drop to travel further through water than either the weaker or the stronger solution, showing that with every solution of a salt there is probably a point to be obtained in the strength of the solution which will give the most perfect ring, and which might be called "the vortex ring strength" of that solution, the drop being caused to fall in each case from the same distance above the liquid.

For the present he thinks it would be perhaps as well to summarize the forces which act in producing these fantastic phenomena, and to do so, it may be well to show the motions of the molecules in the surrounding fluid through which a vortex ring is passing. In order to simplify this, let A rep-

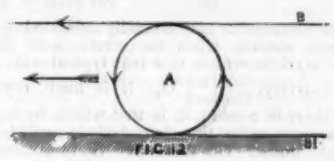


FIG 12

resent a wheel capable of rolling on rails in the direction of the arrow; to render the instance more forcible, let A represent a spur wheel rolling on racks, BB^1, then if B^1 be fixed, B will move in a longitudinal direction shown by an arrow.

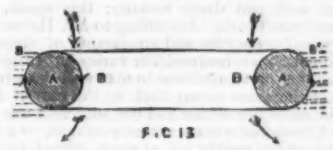


FIG 13

To apply the case to a vortex ring, outside the ring is a relatively vast mass of inert water held powerfully together by cohesion. Let this represent the fixed rail, B^1; inside the ring is a column of much smaller mass of water, which, by the motion of the molecules of the ring, is caused to move bodily through the rings, spreading out in front of it, and causing the ring itself to widen out—and this represents our movable rail, B. Now this explanation is fully borne out by the fact that the faster a ring moves the more slowly does it widen out and become larger, for then the motion of molecules in the ring is much quicker, the column moves with much greater rapidity, causing a cone to be formed whose angles are much smaller, and which causes the ring to widen out at first almost inappreciably, but when the motion rate decreases, to widen with great rapidity. This explanation will also account for the occurrence of the simoom in a previous experiment. Now, to return to the experiment, it seems that each ring is produced by the action of the following forces: (1) By any disturbing action to the gentle flow of the liquid—it is indeed gentle, being that of diffusion—or by any variation of pressure on its surface or on the surface of the exposed lower liquid. (2) By gravity, for the denser the liquid the quicker the flow, and the faster the formation of rings. (3) By the sucking action of the rings which have preceded it, and which aid largely in hurrying it off from the main column. Cohesion is not without action—with gum a strong solution will be obtained, no vortexing; but the solution doubles itself up into knots, like a strongly heated stream of molten glass or like falling treacle, showing that cohesion is not without its action.

Why should not this vortex motion be applied to bodies which have to travel rapidly through fluids—such as torpedoes, flying machines, or fireworks?

WAX.*

By LEOPOLD FIELD.

THE term *wax* used to be applied solely to beeswax, but of late years the introduction of paraffin, solid and liquid, has led to the name being employed to distinguish the first, paraffin proper, from the oil. So the white solid rejoiced in the designation "paraffin wax," until the cognomen being dropped altogether, we find certain companies advertising their goods simply as "wax candles," a confusion of names which must be deprecated, as tending to mislead; perhaps, however, this is the end in view.

Wax may be defined as bodies of a certain viscid plasticity when warmed, consisting of fatty acids of the series $C_n H_{2n} O_2$, either free, or in combination with an alcohol radical; they do not yield glycerin upon saponification, which is effected with difficulty, and the soap formed is sparingly soluble in water. Following these lines, we have the following genuine waxes of interest to us:

		Origin.
Animal	Beeswax.....	*Apis.*
	Spermaceti.....	*Physeter macrocephalus.*
	Pih-la.....	*Coccus sinensis.*
Vegetable	Carnauba wax .	*Copernicia cerifera.*
	Myrtle " .	*Myrica cerifera.*
	Palm " .	*Ceroxylon andicola.*
	Japan " .	*Rhus succedania.*

We will take these seriatim. *Beeswax* is the gift of the ordinary bee. It has long been an open question whether the wax was in the pollen of the flower, the bee acting as a mere vehicle, or whether the insect evolved the wax by some process best known to itself. When, on experiment, it was found bees who were fed entirely on sugar continued

* Abstract from lectures before the Society of Arts, London.

to produce wax, the question was considered settled; namely, that the wax was as genuine a bee product as the silk of the worm. But later investigations show that, after two or three days' sugar diet, the bees fail to supply any more wax, and ultimately die. Carefully considering all I have been able to find upon this subject, I am inclined to think that pollen is necessary for the formation of wax; in the first place, it nourishes the bee, containing nitrogen, which sugar does not; and, secondly, itself containing wax, probably gives the initiatory to the wax-producing organs. It is a fact, that a colony of bees, deprived of pollen, will take eighteen ounces of honey to produce an ounce of wax; whereas, with a proper supply of "bee bread," only fifteen ounces will be consumed in making the same quantity. The wax exudes from between the lower rings on the abdomen of the bee, and is worked up between the fore-paws, for though of high melting point (145° F.), it becomes plastic at 90°, and can be readily moulded. The composition of beeswax has been fruitful subject of discussion among chemists, who have obtained results of startling discrepancy. This is, doubtless, due rather to the adulteration of the wax before analysis than variation in the substance itself; it being generally found that substances of animal origin are very uniform in composition. Mr. Otto Hehner has recently made a most exhaustive investigation of a great number of different waxes, and comes to the conclusion that the average composition is:

Cerolein	(?)
Myricin	0·88
Cerotic acid	0·12
in.....	100 parts of wax.

These two constituents may be easily separated by boiling the wax with alcohol, when the ceratic acid dissolves, leaving the myricin, which is a true typical wax, being a palmitate of myricyl $\left.\begin{matrix}C_{15}H_{31}\\C_{15}H_{31}\end{matrix}\right\}O_2$: it is finely crystalline. Perhaps, if there be *cerolein*, it is that which, by its abundance or exactness, gives the characteristic qualities to all these different waxes. On this stand there are over forty varieties, from every country at all noted for that product, and yet an experienced eye and nose will pick you out and assign most of them to their native lands. Here we have bright yellow wax from Holstein and Denmark, the golden produce of Senegambia, the party-colored mixture from Australian hives, and the soft, dark ceral of Mogador. This gamboge-tinted specimen comes from Mexican woods; this is wasp-wax, soft and dirty looking; this again, almost white, comes from Brazil. According to Mr. Hehner, whatever the physical properties and appearance of these multichroic specimens, their composition varies but little. Even that little he inclines to attribute to man and the advance of civilization, rather than to any fault on the part of the bee. Of old, if the sable bee owner had not sufficient tale of wax, he artlessly introduced a stone or lump of iron, or a bone or two to make up the weight, or, at most, stirred in a quantity of coarse sand. But now every conceivable fat, cheap paraffin (imported for the purpose), palm oil dregs, etc., are employed as adulterants, not detected till the bleaching ground or candle, by defective performance, exposes the deception. There is no remedy. The agent who collects the tributary supplies from a hundred homesteads mixes all the lots, and the hundred agents' deliveries are again thrown together. What help is there? But, by careful sampling, a keen buyer manages to escape with about 75 per cent. of pure wax. This comes to the factory as you see it, and in its present form is useless. The first step is to "clear it down"—which is much the same as "rendering"—boiling with a little weak acid and water, which separates all dross, and leaves the wax clean, though dark in color. The next operation is that of bleaching. This may be done in two ways: by air, or chemical action. The latter can only be applied to wax that is not intended for candles; the grain becomes highly crystalline, and the burning power deteriorates. Why this is, I cannot say as yet; we must look to Mr. Hehner's researches for the future explanation. To whiten the wax chemically, it is treated with sulphuric acid and bichromate of potash, whereby ozone is liberated, and that discharges the color. As the chromium salts impart a powerful green tint to the wax, it has to be boiled considerably with further libations of acid water, till, finally, it assumes this appearance. Observe how short and friable the grain here—you will see the crystalline structure upon closer inspection. If I were authorized to hazard an explanation, it would be, that in the gentle performance of atmospheric bleaching, the *cerolein* (presuming such to exist) only is destroyed; by the violent attack and heat of the chromic-acid, the myricin is split up into acids, palmitic and cerotic. In brief experiments, I have found that air-bleached wax dissolves in alcohol to pretty nearly the same extent as when crude, while the chemically whitened body is far more soluble than before, which, if correct, points to a great increase in the quantity of acid, and decrease in myricin. My assistant is now performing the operation of chemical decolorizing. Observe the deep green color, and great heat, sufficient, as you see, to boil alcohol. After the lecture, I will show you the small cake of wax, not entirely blanched, but much whiter than before.

To bleach beeswax atmospherically requires time and fair weather. The melted wax is allowed to trickle through a slit pipe over a drum revolving in water. This divides it into ribbons, which are rescued from the water by a rake, and spread on long canvas sheets—about forty feet by three feet. Here they sojourn during the fine summer days, being discreetly tossed and turned, and sprinkled judiciously with water, till the color is discharged from the outer film. Again melted and divellated, it undergoes another exposure, and yet, perhaps, another, according to its nature, till of the yellowish white peculiar to itself. It is then run into cakes and stored for use. We may as well follow it to the end and see how it is made into candles. A very favorite method in olden days was to apply the wax, made plastic in hot water, to the wick with the hand, by kneading and manipulation, reducing it to proper form. But this was a lengthy process, and the water was difficult to expel, producing spluttering. The candles were also dipped, like tallow lights; but this method would only answer in short cases, and the generality of wax lights are passing long. Moulding, somehow, will not answer with wax; the candles refuse to leave the moulds, or crack while doing so. So now they are "poured." Round this wooden hoop you will notice a number of strings, to each of which, by means of a little wax, my assistant will join a wick. The hoop is now hung over a caldron of melted wax, "and, be very careful, I pray you," says an old manualist, "of the temperature, lest, all too hot, the wax refuse to adhere to the wick; or too chill, hardens before the whole length be run." Dipping a ladleful from the caldron, the operator revolves the hoop with one hand, while he pours the fluid material over the wicks with the other. After three or four revolutions, that hoop is laid aside, and another taken in hand. On this frame, the candle is arranged *in crescendo*, showing the increment gained after each pouring. At a certain period, the candles are reversed, as the tendency is naturally to thicken at the lower extremity. Being now of tolerably even diameter, though unsightly, they are plucked from the strings, and laid in a row of about six upon a marble slab, sprinkled with water. The maker then proceeds to roll them under a board, upon which he throws all his weight, and by this the still plastic substance is rendered of a smooth and even surface. With knife and gauge, the candles are cut to the required length, and their tops trimmed with a piece of wood. Hand labor, you see, throughout, and requiring much skill and experience. A well made wax candle should show rings like a tree, where the different layers have been superfused.

To make the little Christmas tapers and wax spills, a method called "drawing" is employed. Here the wick is wound off one drum on to another. In its passage it passes through a basin of melted wax, colored with pigment, leaving which it passes through a die, perforated with holes varying in diameter from one-sixtieth to one-half inch. The wick passes and repasses, till sufficiently thick. The large sizes are cut into tapers for Christmas trees, the thin wicks into lengths of about eighth-twelfths inch, and are made up into bundles or assorted colors. To "feather" the ends, to facilitate lighting, they are dipped into hot water, and "flipped" over the arm, the melted wax flying off, and the ends dispersing.

Considering the expense of the raw material, also the skillful labor and time required for its manufacture, it is not surprising that wax candles should be dear, and highly prized. They have long been the currency for paying spiritual debts, and many tons of candles are devoted to this purpose. For carriage lamps, where a hard substance is required to resist the upward pressing spring, wax "moons" were long the only ones adopted, till ozokerit literally "took the shine" out of wax in light and hardness. Many quaint and obsolete customs were connected with the candle, as "selling by candle," when the bid was knocked down after a certain length had burnt; "excommunication by candle"—

"The priest called for candle, for bell, and for book,"

where the grace and time for penitence were adjudged by the same measure.

The introduction of cheaper substitutes has enabled many to reconcile piety and economy. Vegetable waxes are as taintless as beeswax, and being some of them harder, last longer. Of these the name is legion, and we can only consider the most important; but, first, we must devote some little time to the beautiful rival of beeswax, spermaceti, itself a true wax.

Spermaceti (*Wallrarth*, Germ.; *Blanc de baleine*, Fr.) is written in old works *sperma ceti*, testifying to the belief then current that it was the spawn of the whale. The history of the rise of this industry is fraught with interest. Till nearly 1700, men's ideas concerning the nature of the substance were very vague. Sir Thomas Browne excuses his ignorance on the plea that "the learned Hoffmann says, "*nescio quid sil.*" In 1686, doubts were set at rest by the finding of a dead whale on the coast of Norfolk, from which unmistakable spermaceti was taken. When this solid came to be employed in candle manufacture, for which it is so eminently adapted, I do not know. It seems for a long time to have been employed in pharmacy alone. Thomas Browne, for instance, lauds it as a "ground for compound oyls and balsams," and another old savant prescribes it in all cases "where acrimonious humours are to be obtunded;" and so in many others. It is still very largely blended in unguents, as I need not remind you; but, of course, now its chief use is for candles.

The black or Greenland whale fishery was carried on long before the haunts of the sperm or cachalot whale had been discovered. The earliest mention made of the latter is by one Mr. Norwood (1667), who, talking of the Bermudas black whale fishery, "has heard from credible persons of another whale having great teeth—from which they got as it lay dead on the beach, a quantity of *sperma ceti*;" and Mr. Stafford, several years after, speaks of the difficulty and danger of catching the sperm whale, "such is its fierceness and swiftness."

But the matter was not allowed to drop there. America took to the chase so kindly that, between 1775 and 1779, she sent out nearly 500 ships to both North and South Atlantic Oceans, which brought in over 30,000 tons of oil. Mr. Burke remarked witheringly on the sloth of the English in this matter, as compared with the activity of their cousins, "No sea but is vexed with their fisheries, no climate that is not witness of their toils." This appears to have taken effect, for, in 1776, the Government offered a large bounty to the largest cargo of sperm oil brought home under certain specified conditions. From this time forward the cachalot whale must have been surprised to find himself the recipient of such marked attentions.

In the year 1786, above 326 tons of pure sperm oil were introduced into England. The bounty was increased, and almost immediately afterward the great step was taken of doubling Cape Horn, hitherto an unaccomplished feat, and carrying the war into the Pacific, the real home of the sperm whale. The captures now doubled and quadrupled. In 1819, Mr. Enderby, who had already received two bounties for two ships which had made voyages of most unprecedented good fortune, fitted out the Syren. This vessel chose the new hunting grounds of the Japan Sea, and with such judgment that, after two years' absence, she returned with the enormous cargo of 346 tons of sperm oil. The trade being now fairly started, the Government discontinued the bounty. But the impetus given received no check—the gain of sale was sufficient inducement; and the cargoes increased in number and tonnage till 1831, when 7,065 tons came into British ports.

It is difficult for even a fertile imagination to overpaint the advantage which accrued to trade, science, and navigation through the enthusiastic following up of this exciting fishery. We shall find a parallel, perhaps, in the palm oil trade, though of a different scope. When one considers the vast extent of water over which these leviathans roam at will, and the remote fastnesses to which they flee from their pursuer, also the enormous yield got from their carcasses without other expenditure than the fire to "try down" and the barrels to hold the oil, it needs no dilating to show how universal benefit must result.

The details of the fishery are known to every one. Not quite so well, perhaps, the difference between the three whales—the "right," the "sperm," and the "bottlenose." There are, of course, innumerable species of this order of mammalia, ranging from the seal to the porpoise, all of which yield oil; but we can only give the most cursory consideration to the above-named. The Greenland, or "right," whale (*Balæna grænlandicus*), also known as the "black whale," yields whale oil, which in many ways differs from sperm oil. This balæna inhabits northern latitudes chiefly, but is found astray in many southern regions. He is toothless; his mouth is furnished with whalebone, and his head is rounded, the skull being of an entirely different form to that of the cachalot. His fat is also more readily saponified, and deposits little solid on cooling; the lighting and lubricating properties also are far inferior. The cachalot, or sperm whale (*Physeter macrocephalus*), so called from its enormous head—nearly 14 feet high by 25 feet long—is a denizen of the south. His skull is long, depressed, and pointed. The great bulk of the head consists of a dense cellular tissue, infiltrated with spermaceti. This is called the *junk*, and is surmounted by the *case*, which holds nearly a ton of very fine oil and sperm. This is termed the *head matter*, and it is still asserted, in most books on the subject, that this is the only source of spermaceti. The error—for such it is—has arisen from the fact of the head matter being full of the sperm crystals when taken from the head; while the body oil does not deposit till after melting and cooling out. The *blubber* surrounds the whole body in a layer of about 18 inches thick. It is a fine fat, much resembling the fat of hot roast beef, and is hardly solid at ordinary temperatures. This is stripped off the whale, and packed into barrels, unless "tried down" on board ship. Trying down means simply melting, to clear down the fiber and skin from the oil. This soon deposits thick scales of sperm, and arrives at the factories in a semi-solid condition; in winter the barrels have to be steamed to extract the contents. The mass then undergoes several filtrations and pressings. At first it is run into long bags of hair or canvas, and allowed to filter simply by its own weight; any pressure at that stage tending to force the only semi-solid sperm through the fibers. This process is called "bagging." When as much oil has filtered out as possible, the flaky mass is transferred from the long bags to square ones, which, placed between boards in layers, are subjected to pressure by superposed weights, gradually increasing till a certain limit. Hydraulic pressure is then applied, in the cold at first, afterward with the aid of heat, the sperm having been melted and cast into moulds once or twice during the different pressings. Finally the almost white wax is warmed and agitated with a little caustic potash, which removes the last traces of color, and then is cast into blocks. Thus purified, spermaceti is an almost blue-white, glistening, semi-crystalline substance, melting at 113° F. Messrs. Bicknells, the well-known sperm finers, who kindly placed their factory at my disposal for the above information, have prepared this block of sperm for exhibiting the crystals. The interior has been run out while warm, leaving the splendidly serrated interior displayed. They are not true crystals—as far as I know, no distinct form has been isolated—but are, nevertheless, highly structural and characteristic. It is my belief that palmitate of cetyl itself would be crystalline, but that the inseparable constituents prevent this.

The constitution of sperm has received a good deal of attention, though, like all the fats, very difficult to ascertain exactly. It mainly consists, as I said, of cetyl palmitate $\left.\begin{matrix}C_{15}H_{31}\\C_{15}H_{32}O\end{matrix}\right\}O$, which on distillation yields a peculiar substance, called *ethal* (cetyl alcohol, $C_{15}H_{31}OH$), the alcohol of cetene, $C_{15}H_{32}$. On long boiling with potash, sperm, like other waxes, forms a quasi soap, but yields no glycerine, cetyl being liberated instead.

Owing to the pure condition to which it can be brought, and the uniformity of its constitution, sperm makes the finest candles we have for regularity of flame. Having large wicks, to allow of quicker consumption of the easily melting wax, the flame of a sperm candle of ordinary size is greater than those of others. For these reasons, the spermaceti candle, burning 120 grains per hour, has been chosen as the standard measure of light over all the scientific world.

The "bottlenose" whale (*Balæna rostrata*) has been a subject of much doubt, and great though surreptitious utility. It is smaller than the balæna and cachalot, seldom exceeding 30 feet. Although, no doubt, thousands of these fish have been caught, and their oil sold as sperm oil, it is only quite recently that the oil has been made a distinct commercial article. Messrs. Bicknell have taken the matter in hand and extracted, after much experiment, real spermaceti therefrom, of a slightly higher melting point than the cachalot sperm. Mr. Allen has published several communications concerning this oil, on which I may have more to say when we speak of oils proper.

I will now pass on to those of the vegetable waxes which their importance entitles to a brief consideration. There are four that may fairly be deemed regular visitors of the British markets. The first, for beauty and purity, is *Chinese wax*, or *pela*.* This exquisite substance has a longitudinal crystalline fiber, much resembling pure stearine, and yet with something of the flakiness of sperm about it. It is a cerotic *ether*, having the seldom varying composition $\left.\begin{matrix}C_{27}H_{53}O\\C_{27}H_{55}\end{matrix}\right\}O$, cerotate of ceryl, corresponding to the true cerotic ether $\left.\begin{matrix}C_{27}H_{53}O\\C_2H_5\end{matrix}\right\}O$, or cerotate of ethyl. It melts at 180°F., and can be crystallized unchanged from boiling alcohol. The maker of this beautiful compound is a certain little insect, the *Coccus sinensis*, inhabiting China. The body of the grown insect varies in diameter from $\frac{1}{4}$ to $\frac{3}{4}$ inches. The diagram (Fig. 1) showing insect, grub, and twig of tree with a coating of wax, is taken from a sketch in Hanbury's "Science Papers," where there is also a very careful description of the insect itself. Its cultivation demands as much care as that of the silkworm.

The cocoons with eggs are attached carefully to certain trees; after a short time the young insects emerge, and commence operations on the bark; this speedily becomes covered with a white waxy film, in which the insects embed themselves; the branches are then scraped carefully of the adhering crust, which is readily purified, by boiling, from the dirt and insects. Some portions of the wax, with the insulated chrysales, are kept for breeding purposes. The trees on which this insect feeds are for the most part, probably all, themselves wax producers. Its favorite pasture appears to be the *Rhus succedanea*, from the root of which Japan wax is obtained. This circumstance renders it doubtful whether the insect could produce wax upon any tree, given proper climate. My opinion is that the wax is the result of a mutual understanding between the two—a product to which insect and tree are equally essential factors.

The amount of this wax realized is very large, averaging about 200 tons. This the Chinese consume all themselves, the price not allowing it to compete with equally useful

* Chinese, Chang-pih-la. Insect white wax.

English products. A little comes over now and then, but the sales are never large. Its chief use is to "break the grain" of spermaceti, the two crystallizations neutralizing each other; but as cheaper substances answer equally well, there cannot be much demand. But the Chinese, who eat all the animal fat they can get, are very glad of the material for their candles. Their *lobchocks* are made from it; this one is quite characteristically thicker at the top than the base, tapering downward, and colored bright scarlet.

Carnauba, or stone-wax.—This peculiar wax is intensely hard, and its melting point very high—too high for utility, as regards candles at least (185° F.). It is however, I believe, used largely on the Continent as an adulterant, or, perhaps

FIG. 1.—COCCUS SINENSIS (PIH-LA).

legitimately, a hardening mixture, and enters largely into the composition of varnishes, heel-balls, etc. The color varies from light yellow to deep gray green, and it can be bleached to an intense white. Carnauba wax is found adhering as a thin film, like varnish, to the leaves, stalks, and the berries especially of a Brazilian palm, the *Copernicia cerifera*. (Fig. 2.) From these the wax is boiled off, and skimmed into moulds. When congealed, its likeness to stone is so great that, were it not for the low sp. gr. (999), one might easily class it with minerals. The composition of stone-wax is very uncertain. Lewy, a great authority on waxes, finds it to contain 80 per cent. of carbon; and Allen vouches for the presence of a notable quantity of free myricyl or meliasic alcohol $\left.\begin{matrix} C_{30}H_{61} \\ H \end{matrix}\right\}O$. The quantity produced is very large, but I am not in possession of trustworthy statistics.

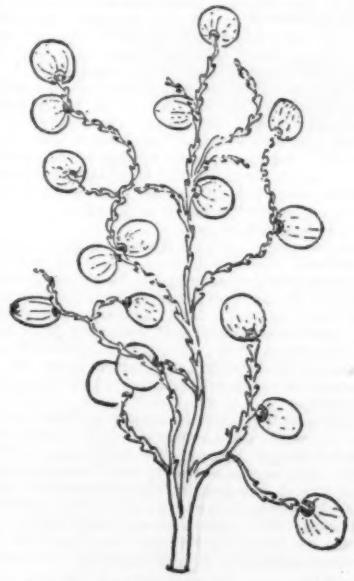


FIG. 2.—COPERNICIA CERIFERA.

The next, and last, of the true waxes is *Myrtle wax* (Myrica tallow). This soft green substance is formed on the berries of *Myrica cerifera*, an American tree shrub. (Fig. 3.) The berries grow in small clusters along the stem, and when ripe are covered with a tolerably thick rind of the wax, which is removed by boiling. This substance is also used chiefly in adulteration, though, from the very low melting point (123° F.), the use must be limited. The composition is chiefly palmitic and myristic acids, with a little glycerine, but has never been accurately determined. *Japan wax*, also called "tree wax," ought properly to rank as a fat, being a palmitate of glycerine, which latter it yields upon saponification. It is derived from the roots of several trees of genus *Rhus*, chiefly from the *Rhus succedanea* of the East Indies. (Fig. 4.) The use of this wax as an adulterant is checked by its disagreeable odor—otherwise, it is a very useful substance; it enters largely into the composition of vegetable wax candles, much used as a substitute for those of genuine bees-wax. Its sp. gr. is about 0·990, the m. p. 120° F. There are several other waxes, of great use in their native countries, as

FIG. 3.—MYRICA CERIFERA.

FIG. 4.—RHUS SUCCEDANEA.

palm wax, from the stem of the *Cerozylon andicola*, Brazil, and *ocuba wax*, from the *Myrica ocuba* of the same country; also Andaquies wax, Cuba wax, and others of uncertain animal origin. The two first-named furnish a large portion of the candle power of northern South America.

[MED. AND SURG. REPORTER.]

SLEEP AND DREAMS.

By W. S. ROLAND, M.D.*

I HAVE chosen this subject, not because of its commonness in practice and experience, but more especially because it is so variously handled by "many men of many minds."

The immediate cause of sleep, as likewise its object, is still an unsolved problem, and will, I think, ever remain an open question for thought and discussion. It is contended by some authorities, that "in the invasion of sleep, the senses first experience its inroads; the sight is dimmed, and the eyelids close; the taste, smell, and hearing are suspended; and lastly, touch ceases to be exercised. The internal senses, as hunger, thirst, and pain, are in like manner suspended. The intellectual and moral faculties suffer the same oppressive lassitude, their exercise becomes languid and painful; the ideas, dull and confused, are formed with difficulty, and without connection; thought is at an end; a species of reverie, or rather delirium, succeeds; and finally every act of the mind is suspended; perception and consciousness, the internal evidences of existence, cease; organic life alone is manifest; animal life for a time has terminated. The act of sleeping resembles, and is in reality, a rehearsal of the act of dying." Now, as I do not indorse the above in all the fullness of its meaning, I shall further on advance and express my belief and opinion.

Dreams "are an intermediate state between sleeping and waking; imperfect consciousness continues, but the faculties are sluggish, and attention is dull; complete suspension of all the psychological operations does not exist; some continue in activity, or awake; ideas are formed, and consciousness is not entirely absent. From this state of imperfect sleep and partial repose of the intellectual and moral faculties proceed dreams."

Dunglison defines sleep: "A temporary interruption of our relations with external objects, a repose of the organs of sense, intellectual faculties, and voluntary motion;" and dreams, "A confused assemblage or accidental and involuntary combination of ideas and images, which present themselves to the mind during sleep."

In that great, grand Book of all books, the following passages are found: "And my sleep was sweet unto me." "Yea, thou shalt lie down and thy sleep shall be sweet." "In thoughts from the visions of the night, when deep sleep falleth on men." "For in the multitude of dreams and many words, there are also divers vanities." "Your old men shall dream dreams, your young men shall see visions," etc.

It is a well-established law of nature that sleep is absolutely essential to the existence of all mankind; the loss of it seriously impairs health, and existence is often shortened; but to enjoy the blessings of "tired nature's restorer," no one should attempt to get to sleep immediately after a full meal nor with an excited and disturbed mind, for to sleep well and to enjoy perfect repose, all gloomy or depressing thoughts should be banished. The duration of sleep is not uniformly the same with all persons; some require more than others. The time requisite for the reparation of the functions of relation is said to be from six to eight hours. Thus sleep occupies nearly a third of life, and he who has reached sixty years, as it respects the operations of the psychological faculties, and including the time of infancy, has not lived more than twenty years. Infancy and old age demand longer periods of sleep, and females sleep more than men. Napoleon slept but little, and Caligula, it is said, but three hours out of the twenty-four. The celebrated John Wesley says that for a period of more than sixty years, he was in the habit of going to bed at ten and rising at four, and that he had six hours of uninterrupted sleep, which he considered to be sufficient for his own health; he, however, very properly remarks that invalids and persons of delicate constitution, and those accustomed to much bodily fatigue, may require from seven to eight hours. Of abnormal somnolence, the *London Medical Record* has the following from the pen of M. Lasegue:

"A barkeeper was often taken with an irresistible desire to sleep while serving his customers, and putting his glasses on the table slept for a few minutes. A porter in a glass merchant's would stop in the streets, lean against the wall with his basket on his shoulder and sleep; then, waking in a few minutes, would rub his eyes and go on his way. A young farmer was out hunting, when he sat down in a field and went to sleep, his companions being unable to awake him. He awoke in five or six hours, but the next day he went to sleep at the same time, and ever since has done so every day. This was a hypnotic sleep, which could be brought to an end by blowing on the face. A young girl went to sleep always at eight o'clock, day or night, with or without a clock. A Belgian countess went to sleep regularly at nine o'clock, whatever she might be doing, and remained until the following day in the position she then occupied. Her catalepsy was joined to hypnotism. She recovered after two years."

Dr. J. Gibbons Hunt, of Philadelphia, on one occasion said that he thought "sleep was only a lazy habit we had got into;" but I think that even if we leave out altogether the evidences from the lower animals, the phenomena of plant life would be sufficient to convince us that organized nature requires rest. Nevertheless, sleep is certainly much under the control of habit. Many of you doubtless have heard the story of the miller who was very sick, and for whose comfort the mill was stopped. But he was unable to rest quietly except under the influence of the noise to which he was accustomed, and the mill was again started. It is in fact a matter of common observation and experience, that the most violent motions or sounds will not wake up a sleeper if he is accustomed to them, and for this reason some sleepers do not wake up during a thunder-storm, the ringing of bells, a passing train of cars, or by the conversation of members of the family, but will awake quickly at a change of noises.

There is a funny story related of an Irishman, and many good stories are peculiar to that class, who, on being told that a severe storm had occurred during the night, said to his companion, "Why did you not wake me up, for you know I can't sleep while it thunders?"

It is asserted that the sensitive plant, so called from its motions imitating the sensibility of animal life, if carried in a railroad car or any other kind of vehicle, will at first close up under the influence of the jolting motion, but will eventually get accustomed to it, will open, and then close when the motion is suddenly stopped.

But the momentous question, What is sleep? I come now to that point where I beg leave to differ somewhat from the quotation in the commencement of this essay. Sleep, in my opinion, does seem to be merely an interruption of the relation between consciousness and sensation, and is not an entire suspension of either of these functions, for I believe that to some extent we smell, taste, hear, and feel when asleep, and the reason that we do not see is simply due to the fact that our eyes are closed, and not to any positive suspension of their powers, and here, in the words of a friendly correspondent, I remark that vision is the only sense which we are able to fully interrupt by special mechanism; we cannot shut our ears, our noses, our tastes, our feelings, against unpleasant sensations, and it has often been the expressed wish of many, "Oh, if I could only shut my ears as easily and completely as I can shut my eyes, what a satisfaction it would be!"

But to return to the subject, we know that consciousness is not wanting in sleep, because dreams are evidences of its power; it must then appear that there is simply an interruption of the relation between these two functions, and the act of waking is simply the restoration of the normal relation between them. In true anæsthesia, the influence is more profound; the activity of both sensation and consciousness is diminished; as under the influence of anæsthetics the sensations experienced are, so far as impressions go, very different from those of naturally going to sleep or awakening.

As a general rule persons do not sleep well in a change of beds or in new places; this may be due to an unconscious influence of the instinct of self preservation, the mind being in a temporarily alarmed state. There may also be something in the position of the sleeper in reference to the points of the compass; some persons think they can sleep best with their head to the north, and others to some other point. If the view that sleep is a break between sensation and consciousness is correct, then we should expect that as we awake, this relation is gradually restored, and we may have a confused or mistaken interpretation of consciousness, which we call a dream. It is doubted by some, and I incline to the opinion that dreams do not occur during a profound sleep; many think that they only do occur at the moment of transition from sleep to waking, or *vice versa*, circumstances that may cause dreams. If, for instance, by some accident, one's foot should get uncovered during a cold night, the sensation of cold would be finally sufficient to push its way through the dormant brain cells until the consciousness was reached, and then might come an imperfect perception, which the mind would refer to some cause known to be capable of producing it; thus the person might dream he was walking on ice. I lean to the view that dreams are never out of the sphere of our experience, that nothing is ever revealed to us through them, and I am sure that often they do not represent the most important topics upon which the mind may be engaged. Sometimes we dream (though somewhat disconnected) of our daily duties, and very often of secondary matters. Dreams present some features which seem to be common to all persons. It is not an uncommon thing, especially with women, to dream of being naked in the street. This is obviously the result of circumstances under which they retire. If they went to bed fully dressed, such dreams would be rare. It is not an uncommon thing to dream that one tries to run and

* Written for the York County Medical Society.

cannot. This I believe is due to the recumbent position; the usual stimulus to the soles of the feet is missing, and the pressure of the bedclothes upon the lower limbs gives a sensation of restraint, which makes us think we cannot run. Such dreams always occur when we are nearly awake. Sometimes we hear persons say that a dream occurred long after they got asleep or long before they got awake, but I doubt whether they can tell anything about it. If dreams do ever occur during a profound sleep, they are purely subjective, that is, they arise from influences entirely within the body. Such are the dreams produced by indigestion, disordered blood, etc., and are not the result of impressions on the senses proper, though even in such dreams it is not improbable that for the first effect of the subjective influence to partially wake the sleeper and then produce the dream.

There is nothing more desirable than a good, sound, refreshing sleep, and if there is any preventive of dreams, it is found in good health, a clear conscience, good digestion, and absence from all exciting and stimulating causes.

The *British Medical Journal* describes some interesting experiments on this subject that have been made by M. G. Delaunay. According to psychologists, dreams are generally illogical and absurd. M. Delaunay, however, by covering his forehead with a layer of cotton wool, rendered at will his dreams healthy and intelligent. According to his experience, the dreams which people have when lying on their backs are sensuous, agitated, and erotic. Those which occur when the dreamer is lying on the right side are changeable, full of exaggeration, absurd, and relate to old recollections. Those which occur when lying on the left side are intelligent, reasonable, and relate to recent occurrences. People often talk during the last mentioned dreams. The author considers that dreams, intelligent or otherwise, erotic or sober, can be induced by causing variations in the cerebral circulation, and by the nutrition of the various regions of the brain, either by the elevations of the cranial temperature or by decubitus. They, therefore, form an interesting field for psychological researches.

Much of the above, in my opinion, is dubious.

DR. HOOKE.

By C. STUART MURRAY.

THERE is no name that fills so large a space—and justly fills it—in the horological mind as he who is the subject of the present paper. So scientifically practical, so invaluable, and so enduring in its permanent effects upon the material advancement of civilization has been his great invention of the balance spring to watches, that he well deserves a prominent pedestal in the temple of fame. Where would have been the measurer, the truthful measurer of longitude; where would have been the trustful monitor in sunshine and in cloud to the noble ship cleaving her undaunted course through the pathless waves—had the balance spring remained unknown? The more the matter is thought over, the more expands the marvel—the marvel that a few coils of steel wire, suggesting a human hair, attached to the axis of a reciprocating wheel in motion, should so regulate the action of its kindred machinery—machinery that can be made sufficiently small to work in the waistcoat pocket, that the observer can, as it were, confidently wend his way among the stars! Yet so it is, and so may it continue moving toward perfection. There is an ancient philosophic maxim that when the want of something great for mankind has been established, then arises the man to supply it. And there is much truth in this; for so it was here, and so it has been in many another case along the joyful halting places of scientific discovery.

Robert Hooke was born on the 18th of July, 1635, at Freshwater, in the Isle of Wight, his father being the minister of that parish. And here let me add, that whenever the horological devotee goes for his holiday, let him think of "The Island." It may be somewhat singular to say, but there are scarcely ten holiday visitors in a hundred to the Isle of Wight who could tell you off-hand where Freshwater is! The place is mostly spoken of as Freshwater Bay, and it is fitting that all who are engaged in the watch trade should know a little about this summer resort. Freshwater lies inside the mouth of the Solent, or continuation of that arm of the "Southampton water" which runs from the last-named town to the sea. The best way of reaching it is from Lymington by ferry across to Yarmouth, and on by road to Freshwater village. The rectory is adjoining, but no doubt there may be traditions of the great horological worthy extant in the neighborhood. Continuing his course onward from the village and the rectory, the visitor will arrive at Freshwater Gate, looking out upon the bay. Cities and towns will be left behind him, while the broad expanse of the English Channel, with its yachts and boats and great ocean steamships, sailing onward and toward, will be before him, a very living panorama. This is the western part of the Isle of Wight, terminated by the well-known Needles round by "Sun Corner," and on to Alum Bay. The scenery, even for the Island, is exceptionally beautiful.

Having shown a taste for drawing, young Hooke was, soon after his father's death, entered as a pupil under Sir Peter Lely. We thus see by his surroundings that he was living and learning among the most highly cultured society of his time. It may not be, and indeed is not, generally known that the royal portrait-painter of the court beauties of Charles the Second's days was, in his real name, Peter Vander Faes. Those who go to Hampton Court may see some of his work adorning the walls of that palatial building. Hooke's delicate health, however, forbade his applying himself to painting, and he consequently abandoned it; and his family seeing this, decided to send him to Westminster School, at that time looked upon as one of the severest places of education in England—probably is so still.

Amid such natural grandeur was the great scientific benefactor ushered into the world, and, as stated, was sent to Westminster School, under the "terrible" Dr. Busby. Why he became such a terror to the boys has never been clearly explained, for he began his own career in poverty. He passed from Westminster School to a studentship at Christ Church, Oxford; while so poor was he that the parish of St. Margaret's, Westminster, and the college joined in paying his first academical degrees. He did not forget the favor, for he left in his will £50 to the poor housekeepers of St. Margaret's. This was in addition to £25 a year to the same parish for charitable purposes. After having been a rector at Wells, in Somersetshire, in 1640, he was appointed head master of Westminster School. He remained there for more than five-and-twenty years, and was considered a hard-working teacher for his age. He certainly never spoiled the child through sparing the rod, always acting well up to the ideal of King Solomon in such matters. It is of him that it is recorded that when Charles the Second visited the school, he declined to unbonnet to his sovereign. Upon being remonstrated with for such apparently disloyal conduct, his answer was that his boys looked upon him as the greatest man in England; whereas, if they saw him take his hat off to any one, he would immediately sink in their estimation to a depth below redemption, and the school would break out into a state of uncontrollable mutiny. At the same time, he hoped that his Majesty would graciously permit him humbly to pay his loyal and dutiful homage out of the sight of the pupils! It is stated that amid much good-natured merriment the request of the learned doctor was willingly granted. In 1660 he was made prebendary of Westminster, with the addition of other preferments; and in 1661 he had the high honor conferred upon him by the king, of carrying the *ampulla*, or vessel containing the anointing oil, at the coronation of Charles the Second. Although his discipline in the school is said to have been very severe, even for his day, yet he took all the morally objectionable parts out of certain Latin classics, so that his boys could read and study them in a harmless manner. One of the most extraordinary things in his history is, that no records of him have been preserved in the school over whose destinies he had so long and so ably presided. He died, "full of years and reputation," on the 6th of April, 1695, and was buried in Westminster Abbey. Over his grave a monument was erected, which may be seen by visitors who are that way interested.

Such was the man and such the tutor under whom young Hooke was placed to be educated. He was intended for the church, and in due time to succeed his father in the comfortable and pleasant rectory of Freshwater; but the weak state of his health, and his continued subjection to headaches, obliged his family to abandon all hopes in that direction. On account of his tedious complaint he was left very much to himself; he turned his attention to practical mechanism, and made toys which showed much ingenuity. He, too, entered Christ Church, Oxford, in the year 1653, but had not been long there before he joined the Philosophical Society of Oxford, and soon became an assistant to Dr. Wallis, the professor of chemistry to the society. He afterward filled the same office for Mr. Robert Boyle. This Robert Boyle also became famous in scientific history. He was the seventh son and fourteenth child in a family of fifteen, of Richard Boyle, Earl of Cork, and was born on the 25th of January, 1626, at Lismore, Ireland. The incidents of his early life and education have been entirely overshadowed by his investigations in chemistry and medicine. He constantly refused a peerage and other dignities, although possessed of a large fortune. This fortune he laid out in experiments, and in assisting in various ways in the dissemination of knowledge. He died on December 30th and was buried in the vaults of St. Martin's-in-the-Fields on January 7, 1692, a funeral sermon being preached on the occasion by Dr. Burnett, the author of one of the histories of the Reformation. He was the personal friend of three kings, a man of whom all his contemporaries spoke well, and had both high honors and emoluments at his call, indeed pressed upon him, but which his scientific mind as constantly refused. As bald notices of celebrities are to be avoided when practicable, I have given here some particulars of Dr. Hooke's surroundings, and the kind of men under whose guidance he commenced his valuable career. Turning his attention to horology, he made a clock, all the wheels of which were of wood. It kept the hours regularly, and was highly prized.

He had a great aptitude for mechanical work, and materially assisted Mr. Boyle in constructing the then newly-invented air-pump. He became versed in astronomical matters, and constructed some instruments for observing purposes. In 1662, he was appointed curator of experiments to the Royal Society, which then met at Gresham College. He was engaged to show members at every meeting several original experiments devised by himself, and to follow out such as might be recommended to him by the Society. This led to his making several important discoveries relating to the nature and properties of air.

The Royal Society of London for Improving Natural Knowledge was instituted in 1660, and incorporated by royal charter in 1662. As at present constituted, it is held to be the oldest society of its kind in Europe, except one that exists at Rome. In 1663, a second charter was granted to remedy some otherwise incurable defects in the one of the year previous. When this charter was obtained, Dr. Hooke was appointed on the council, the repository of the Society was committed to his care, a gallery in the Gresham College of the time being set apart for its reception. In 1664 he was made "Professor of Mechanics," with a salary of £50 a year.

Before I go any further, I may as well mention the learned characteristics of the Society. It is divided into a number of committees, embracing mathematics, astronomy, physics and meteorology, chemistry, mineralogy, and geology, botany and vegetable physiology, zoology and animal physiology making seven committees in all, but which may now take in other subjects not then specially recognized.

The Royal Observatory at Kew is held by the Society under a grant from the Crown; it has for its presidents such eminent men as Sir Isaac Newton, Sir Joseph Banks, Sir Humphry Davy, etc.

From a recent visit there, I am of opinion that the Observatory is now chiefly occupied in the study of meteorology, electricity, and terrestrial magnetism. From these details it will be understood that our "Worthy" was breathing the very atmosphere of his scientific life.

In the same year that he was made professor of mechanics, he succeeded Dr. Dacres as professor of geometry. In 1665, he published his "Micrographia, or some Physiological Descriptions of Minute Bodies made by Magnifying Glasses," with a dedication to the king. In 1668, Hevelius, having sent to Hooke a copy of his *Cometographia*, the latter returned the compliment by means of a copy of a tract describing his newly-invented "dioptric telescope." Every one knows what the word telescope means; but, perhaps, to readers whose lifetime has been for the most part spent away from costly learning, the term dioptric may not be so clear. In that case, perhaps, they will not deem me obtrusive, if I venture with some diffidence on my own part to tell them. Dioptric, then, is formed of two Greek words—*dia*, through; and *optomai*, to see. It is that part of optics which treats of the refraction of light passing through different mediums, as through air, water, or glass. As applied to telescopes, in which sense it is mostly used, it is the passing of the rays of light *through* the lenses that enables the observer to *see* more clearly than otherwise distant objects; in fact, to discern things that could not be taken in by the unassisted eye at all.

Joannes Hevelius, as Latinized, or, more properly, John Hevel, a Polish nobleman, and an astronomer of singular eminence in his time, was born in 1611. He had traveled through the principal countries of Europe before he was twenty-five years of age, after which he returned home and devoted the remainder of his days to the close study and observation of astronomy. Among many productions from his pen he published, in 1673, the first part of his *Machina Cœlestis*, which gave rise to a long and angry controversy between Hooke and himself. Dr. Hooke did not shine in the encounter, through his dictatorial temper. Hevelius resided at Danzig, and ranks next to our first Astronomer Royal, Flansteed, as an industrious, accurate observer. He died in 1688, in his seventy-sixth year. I have not ascertained whether or not the quarrel between the two distinguished men had ever been healed.

After the fire of London, Dr. Hooke offered a plan to the Court of Aldermen for the rebuilding of the City, which, although not carried out, procured him the appointment of a City surveyor. This, it has been stated, helped him to the acquisition of considerable property. In 1673 he proposed "A Theory of the Variation of Compasses," and in the following year "An Attempt to Prove the Motion of the Earth from Observations." Next came a paper on helioscopes, or sun telescopes, and "A Description of some Mechanical Improvements." In 1677 he became secretary to his Society. 1691 he was created "Doctor of Physics," by a warrant from Archbishop Tillotson. He claimed Newton's discovery about force and the action of gravity, but got thoroughly worsted in the argument. In 1678, was published his lectures, *De Potentia restitutiva, or of spring bodies*. This was the grand work for the future student-horologist, which will be further referred to presently. He died at Gresham College in 1702, in his sixty-eighth year, and was buried in St. Helen's Church, Bishopsgate Street, his funeral being attended by all the members of the Royal Society, and a vast concourse of people. He was always at work, and left a numerous collection of scientific papers behind him. The wonder was how a short, thin, crooked-made, delicate man could have written them all. But it was well-known that, in addition to what he did during the day, he seldom went to bed until two or three o'clock in the morning, and sometimes he was up the whole of the night.

He thus commences his paper *De Potentia restitutiva*: "The Theory of Springs, though attempted by divers eminent Mathematicians of this Age, has hitherto not been Published by any. It is now about eighteen years since I first found it out, but designing to apply it to some particular use, I omitted the publicity thereof.

"About two years since, I printed this Theory in an Anagram at the end of my Book of the Description of Helioscopes, *viz.*, c e iii n o sss tt uu, *id est*, *Ut tensio sic vis;* that is, The Power of any Spring is in the same proportion with the Tension thereof. That is, if one power stretch or bend it one space, two will bend it two, and three will bend it three, and so forward. Now, as the Theory is very short, so the way of trying it is very easy. Take then a quantity of even-drawn wire, either Steel, Iron, or Brass, and coyl it on an even cylender into Helix of what length or number of turns you please, then turn the ends of the wire into Loops, by one of which suspend this coyl upon a nail, and by the other sustain the weight that you would have to extend it, and hanging on several Weights, observe exactly to what length each of the weights do extend it beyond that length that its own weight doth stretch it to, and you shall find that if one ounce, or one pound, or one certain weight doth lengthen it one line, or one inch, or one certain length, then two ounces, two pounds, or two weights will extend it two lines, two inches, or two lengths, and so forwards. And that is the rule or Law of Nature upon which all manner of Restituent, or Extension, or Condensation and Compression moves?" He also says: "About three years since His Majesty was pleased to see the experiment that made out this Theory tried at Whitehall, as also my Spring Watch." The full title of this paper is itself interesting to us now. It runs thus:

"Lectures de Potentia Restitutiva, or of Spring Bodies, by Robert Hooke, S.R.S. London: Printed for John Mariyn, Printer to the Royal Society, at the Bell, in St. Paul's Churchyard, 1678."

S.R.S. means "Secretary Royal Society."

In the same paper he gives directions for coiling a watch-spring into a spiral, and trying it on a wheel mounted on an arbor with steel pivots, and coiling a small silk thread on the arbor, the wheel being in a frame suitable for the purpose. At the free end of the thread is to be attached a scale to hold a weight, and an index to mark the action of the spring with the different weights and the distance that the wheel will move. By such an arrangement the ratios of the actions will be arrived at. As the discovery was published in 1668, and Hooke says that he found it out some eighteen years previously, that would lead back to the year 1650, or more than two hundred and thirty years ago! A goodly number of watchmakers and watch wearers since then have had much reason to be grateful to the labors and to the memory of Dr. Hooke. He speaks about being in treaty with several "persons of honor" to discover some invention for measuring time by applying springs to the arbor of the balance of a watch, regulating the vibrations in all positions. Upon reading the whole of the case, it does not appear that the "persons of honor" behaved in the affair quite as honorably as they might have done.

The fragile nature of Dr. Hooke's bodily powers has been mentioned, and I will here say a few words more about it. In personal appearance he looked very uncomely. His figure was crooked, his limbs shrunk, his face haggard, while his long, unkempt hair, hanging closely over his shoulders, gave him a weird and unearthly look—far from showing indications of the rich, active mind within. Perhaps the reader will be a little surprised to learn that he suggested a mode of weather forecasting and a system of telegraph signaling.

He investigated the nature of sounds, and the function of the air in respiration and combustion, and is said to have originated the idea of the pendulum being used as a measure of gravity. His inventive faculty was surprisingly great, but seemed almost surpassed by his mechanical faculty, and his unrivaled sagacity in the discovery of the general laws of phenomena. His paper, already mentioned, entitled "An Attempt to Prove the Motion of the Earth from Observation," was published in the *Philosophical Transactions*, in 1674. He says:

"I will explain a system of the world differing from any yet known, but answering in all things to the common rules of mechanical motions, which system depends upon three suppositions.

"1. That all celestial bodies whatsoever have an attraction or gravitating power towards their own centers, whereby they attract not only their own parts, and keep them from flying from them (as we may observe the earth to do), but also all other celestial bodies that are within the sphere of their activity.

"2. That all bodies whatsoever that are put into a direct and simple motion will so continue to move forward in a straight line till they are, by some more effectual power, deflected and bent into a motion that describes some curved line.

"3. That these attractive powers are so much the more powerful in operating, by how much nearer the body wrought upon is to their own centers."—*The Watchmaker.*

PROFESSOR HUXLEY.

THOMAS HENRY HUXLEY was born at Ealing, Middlesex, May 4, 1825, was educated at Ealing School, and studied medicine at the Medical School of the Charing Cross Hospital. He was appointed Assistant-Surgeon of H.M.S. Rattlesnake in 1846, remained with that vessel during her surveying cruise in the South Pacific and Torres Straits, returned to England in 1850, and in 1854 succeeded Mr. Edward Forbes as Professor of Natural History in the Royal School of Mines, in Jermyn Street. About the same time he was appointed Fullerian Professor to the Royal Institution, and Examiner in Physiology and Comparative Anatomy to the University of London.

His first publication was a valuable work on the "Oceanic Hydrozoa," the fruits of his investigations during the cruise of the Rattlesnake off the Australian coasts. In 1860 he delivered in Jermyn Street a course of lectures to working men on the question of the Origin of Species, to which subject attention had just then been attracted by Dr. Darwin's great work. The substance of these lectures, with additions, was afterward published by Mr. Huxley in a book entitled "Evidence as to Man's Place in Nature," which aroused great popular interest, and was translated into several foreign languages. His other works, comprising numerous papers written for various learned societies, are too numerous for separate mention here. One merit they all possess. However abstruse the subject matter may be, they are distinguished by a remarkable lucidity of expression.

In 1870 Mr. Huxley was chosen as a member of the London School Board, from which he retired two years later. In 1872 he was elected Lord Rector of Aberdeen University, and in 1878 he received the honorary degree of LL.D. from the University of Dublin. Recently, on the death of Mr. Spottiswoode, Professor Huxley was chosen to fill his place as President of the Royal Society, of which body he had previously been one of the Secretaries.

Concerning this appointment, the *Lancet* speaks thus:

"The requirements of the office are numerous; he who holds it must be thoroughly versed in at least one branch of human knowledge, and be regarded by those who are most familiar with it as its most brilliant exponent. But he must be something more than this, and be capable of recognizing and appreciating the value of other lines of thought and research than those at which he has worked. Lastly, he must be fitted to conduct the business relations of a large and rich society. No one combines these qualifications for the office more perfectly than Professor Huxley. He has been an energetic and steady worker, and is the unrivaled head of biological science in this country. He may be ranked next to Darwin himself as the ablest exponent of the doctrines of evolution; he is a subtle dialectician, and as a man of wide and liberal education may be depended on to promote the cause of science by every legitimate means."—*London Graphic.*

THE GLACIAL PERIOD IN ILLINOIS.

AT a recent meeting of the St. Louis Academy of Science, Mr. William McAdams was introduced, and invited to exhibit some rare specimens he had excavated in various parts of Illinois. The gentleman, in explaining his specimens, with the view of throwing as much light as possible on the subject, read the following paper:

"The last great convulsion of nature, under the guidance of an all wise Providence, ended the geological epoch and finished the earth, leaving it in its present outward form, which is called by geologists the quaternary or drift period. During this period the earth, from some cause not easily explained, became covered toward the poles with an enormous envelope of ice, which after a time, from causes also obscure, melted and moved toward the equator, eroding away the upheaved prominences and filling up the valleys with clay and other debris that in the end left a great area of the country, especially in the Mississippi Valley, with the general level surface upon which the rich soil of this great region reposes.

"The deposits of the drift, as seen in digging wells and making other excavations, as well as in the precipitous exposures made by water courses, consist usually of a reddish brown clay, underlaid by a bluish plastic clay lying on the surface of the rock, which is usually reached in both Illinois and Missouri at a depth of less than one hundred feet. This depth, however, is sometimes exceeded where the valleys of ancient streams are met with.

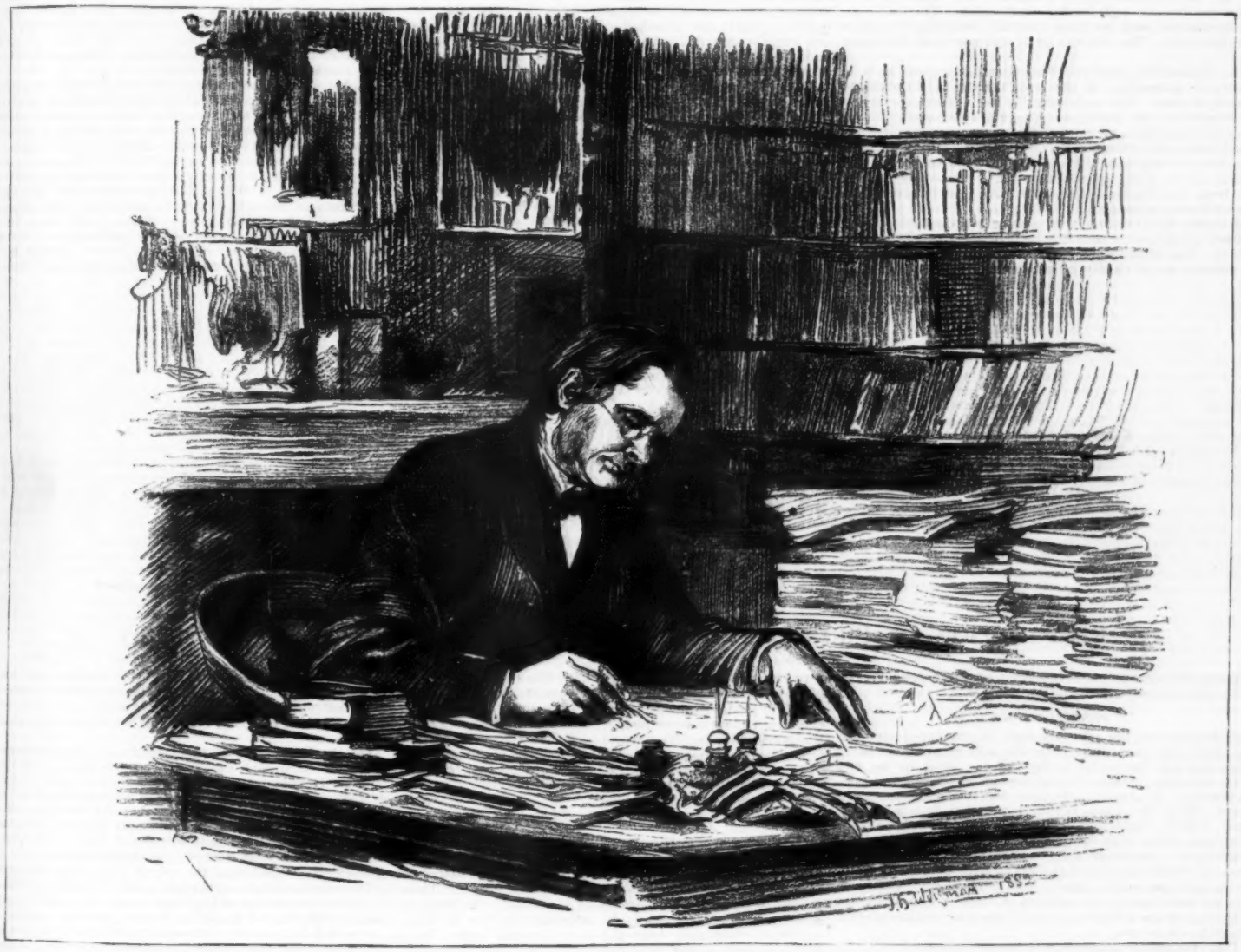
"Mingled with these drift-clays are many bowlders and masses of rocks of great interest, from the fact that they are often of different material from any rocks we have in place in Illinois. It is quite common to find granite, porphyry, greenstone, and other primary rocks that have evidently come from the region of Lake Superior. It is not uncommon to find masses of native copper, doubtless from the same northern locality. The present specimens of this copper are from the drift in the neighborhood of Alton and near Grafton. It is quite probable that a period of many years elapsed—ages, in fact—during the subsidence of the drift-glaciers; and although it may not be quite certainly ascertained that man beheld the phenomena of this epoch, it is quite certain that many strange animals braved the rigors of the climate and evidently flourished. Some of these animals were of strange appearance, and where their bones are discovered protruding from the clays, one is astonished at their size. From the clay in the side of a ravine in Calhoun Co., Illinois, we recovered the jaw of an elephant beside which Jumbo would seem small. One of the teeth from this fossil jaw, and which we present for inspection, weighs near eighteen pounds, being much lighter in its fossil state than when in the mouth of the living animal. The teeth of this great glacial elephant are quite different and much larger than those of the mastodon, which also existed during the same period. The teeth of this extinct elephant very much resemble the teeth of the elephant of the present day. We have also taken from the drift clays above Alton the teeth and several bones of a huge carnivorous animal allied to the bison, probably the extinct *Bos latifrons*, the spread of whose horns would make those of a Texas steer seem very small in size.

"It is quite probable that during this period more than one species of horse existed. Bones of extinct horses are quite numerous in the Tertiary deposits about the base of the Rocky Mountains.

"In digging a well in Greene Co., Illinois, the workmen found at the bottom of the excavation the teeth of an extinct horse somewhat resembling those of the present day. We also have seen the fossil tooth of a horse from near Alton. All the remains of the horse we have seen from the 'drift' are of large animals, while the majority of the fossil horses from the 'bad lands' of Dakota are quite small.

"Along the banks of the Mississippi the character of the 'drift' deposits is somewhat changed by a sort of lacustrine marly clay left during the slow subsidence of the waters down the river valley after the ice had melted away. This marly clay deposit which caps the river bluffs is called loess, and passes gradually into the drift clays below. It is somewhat remarkable that with the many fluviatile shells and remains of land animals in the loess, we also occasionally find the remains of animals almost wholly marine. From the loess above Alton a few years ago was recovered the skull of a species of walrus with curved tusks down from the upper jaw and much resembling the walrus now inhabiting the Arctic seas. From the clays over the quarries at the mouth of the Illinois River we have taken the remains of a large and undescribed animal that had apparently curved tusks depending from the upper jaw, not unlike the walrus. These tusks were some three feet in length, the smooth surface of the ivory being raised longitudinally in fluted parallel lines, quite unlike the tusk of any known animal. We present portions of these tusks for inspection. Both in the true and modified drift we have seen the remains of rodents, some of them small; but one, an extinct beaver, was of monstrous size. Some of these animals, from the fact that their remains have been found in the mire of swamps, survived the drift period and became extinct in later periods. This is especially true of the mastodon. As little as is known of the animals of this period, still less is known of the vegetation. We also present specimens of wood from the same horizon.

"At one locality on Otter Creek, in Jersey Co., Illinois, the stream cutting through an ancient valley filled with drift-clays, there is exposed beneath the drift-clays a pre-glacial soil near four feet in thickness. In this curious deposit wood and other vegetation are numerous. A tree lies prone



PROFESSOR T. H. HUXLEY, PRESIDENT OF THE ROYAL SOCIETY.
DRAWN FROM LIFE.

Thomas H. Huxley

in this soil, with parts of the limbs still attached. The trunk of the tree, of which we present a section, with portions of the limbs adhering, is flattened and almost turned to lignite by pressure and lapse of time. But what is still more interesting are the cones or fruit which the tree bore. These cones are about an inch in length and somewhat resemble those of a species of conifer, different, however, from any known species. We place before you other remains of this ancient vegetation."

Judge Holmes, in commenting upon the specimens, stated that marine deposits had been found in a peculiar stratum which was supposed by geologists to extend as far south as the mouth of the Ohio River, and that the tusks referred to in the paper would be a valuable discovery if they proved to be those of a walrus.—*Globe Democrat.*

[AMERICAN JOURNAL OF SCIENCE.]

RESTORATION OF BRONTOSAURUS

By Professor O. C. MARSH.

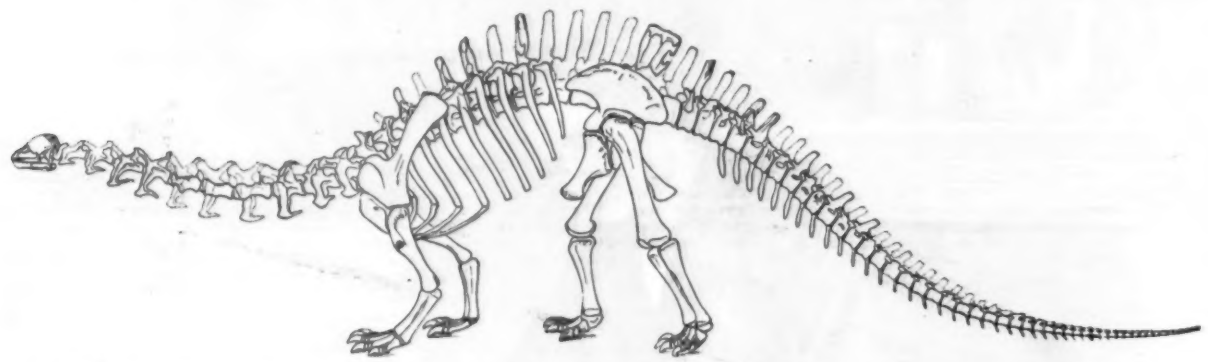
NEARLY all the bones here represented belonged to a single individual, which, when alive, was nearly or quite fifty feet in length. The position here given was mainly determined by a careful adjustment of these remains. That the animal at times assumed a more erect position than here represented is probable, but locomotion on the posterior limbs alone was hardly possible.

The head was remarkably small. The neck was long, and, considering its proportions, flexible, and was the lightest portion of the vertebral column. The body was quite short, and the abdominal cavity of moderate size. The legs and feet were massive and the bones all solid. The feet were plantigrade, and each footprint must have been about a square yard in extent. The tail was large, and nearly all the bones solid.

The diminutive head will first attract attention, as it is smaller in proportion to the body than in any vertebrate hitherto known. The entire skull is less in diameter or actual weight than the fourth or fifth cervical vertebra.

A careful estimate of the size of *Brontosaurus*, as here restored, shows that when living the animal must have weighed more than twenty tons. The very small head and brain, and slender neural cord, indicate a stupid, slow moving reptile. The beast was wholly without offensive or defensive weapons, or dermal armature.

In habits, Brontosaurus was more or less amphibious, and its food was probably aquatic plants or other succulent vegetation. The remains are usually found in localities where the animals had evidently become mired.



RESTORATION OF BRONTOSAURUS EXCELSUS, MARSH. (One-eighteenth natural size.)

Among the new points in the skull of the Sauropoda recently determined, are the following:

PITUITARY FOSSA.

In *Morosaurus*, the pituitary fossa is comparatively shallow, much like that in the crocodile and many birds, being connected with the under surface of the skull by the two usual divergent foramina for the passage of the internal carotid arteries. In *Apatosaurus*, however, it is remarkably different. Here the fossa becomes enlarged into a vertical canal, which, expanding below, communicates by a wide transverse orifice with the pharyngeal cavity. The arterial foramina are here canals thinly covered over with bone, and open just within the rim of the lower orifice. The pituitary cavity itself has a firm, smooth wall throughout. The openings are both transverse, and oval in shape. The upper one is eighteen by six millimeters in its diameters; the lower opening thirty by twelve.

This remarkable connection of the cerebral cavity with the alimentary canal is an embryonic character, and corresponds to the condition observed in the chick at the fifth day of incubation. This peculiar feature appears to be a family character of the *Atlantosauridæ*.

POST-OCCIPITAL BONES.

In two genera of the *Sauropoda* (*Morosaurus* and *Brontosaurus*), and probably in all members of this order, there is a pair of small bones connected with the skull which have not hitherto been observed in any vertebrates. These bones, which may be called the *post-occipital* bones, were found in position in one specimen, and with the skull in several others. When in place, they are attached to the occiput just above the foramen magnum, and extend backward and outward, overlapping the lateral pieces of the atlas, thus protecting the spinal cord at this point, which would otherwise be much exposed.

These bones are short, flattened, and slightly curved, resembling somewhat a riblet. The anterior end is thickened and rugose for an attachment to a roughened surface on the exoccipital just above and outside the foramen magnum. The shaft is flattened from above downward, and gradually converges to a thin posterior end. In *Morosaurus grandis*, these bones are about 65 mm. in length, and 30 along the surface which joins the occiput. They correspond in position to the muscle in mammals known as the *rectus capitis posticus minor*.

In the existing Cormorants (*Graculus*) a single slender bone is articulated to the occiput on the median line. This, however, does not correspond to the bones here described. To distinguish it from the post-occipitals, it may be called the *nuchal* bone.

STAPES WANTING.

In the skull of *Morosaurus* in which the post-occipital bones were found in position and the other bones at the base of the skull were undisturbed, a careful search was made for the stapes, but no indication of it was found. Its absence in this specimen, so well preserved, would indicate that it was wanting in this genus if not in the other Sauropoda.

COLUMELLA PRESENT.

In a skull of *Brontosaurus* in which the bones, although displaced, were in very perfect preservation, a pair of bones were found which apparently are the columellæ. They are elongated, flattened bones, with the shaft somewhat constricted in the middle, and twisted. Their length corresponds to the elevated posterior part of the skull in this genus.

HYOID BONES.

There are two pairs of hyoid bones in the Sauropoda. They are elongated, rodlike, and somewhat curved. In *Brontosaurus excelsus*, they are 210 and 180 mm. in length respectively.

Among the other points of interest in the skull of the *Sauropoda* are the following:

The parietal bones are very short, and form but a small portion of the brain case. They are composed chiefly of the flattened arched processes, which meet with the squamosals at their outer ends. There is no parietal foramen. The squamosals lie upon the par-occipital processes. They have a short deep groove for the reception of the post-frontal. On their lower part, which descends in front of the par-occipital process, they expand into a thin, spoon-shaped form, which fits over the head of the quadrate. The quadrate has an oval, rounded head, and slender shaft. Below, it is firmly united to the pterygoids. On the outer side, the quadrato-jugals are attached. These bones are elongate, and slightly sigmoid in shape. The lower end is rodlike, and curved forward, descending below the articular surface of the quadrate. The pterygoids are tri-radiate bones, with the posterior ends cupshaped, resembling the partially closed human hand. This cavity, somewhat restricted by a thumb-like process, receives the basi-pterygoid process.

THE VERTEBRÆ.

There are twenty-seven precaudal vertebræ in *Brontosaurus*, of which the first twelve bear pleurapophyses, or hatchet bones, united to the centra, and may hence be called true cervicals. Of the remaining twelve which bear free ribs, the thirteenth, fourteenth, and fifteenth have the surface for the articulation of the head of the rib on the centrum, below the neural suture.

All the precaudal vertebræ have large cavities in the centrum, communicating exteriorly with the surface by means of large lateral foramina. This cavernous structure of the vertebræ gradually decreases posteriorly, until in the anterior caudal vertebræ it is confined to a small pocket above the transverse process. The neural arches of the presacral vertebræ contain numerous deep cavities. The pleurapophyses of the cervical vertebræ are also reticulate in their structure, and some of the anterior ribs have small but deep fossæ below the tubercle.

POST-METAPOPHYSES.

On the last two or three cervical vertebræ of *Brontosaurus* there is a convoluted ridge of bone over the posterior zygapophyses. In the anterior dorsals, this ridge becomes stronger and more elongated, forming a distinct protuberance. These processes have not hitherto been described. As they are analogous to the processes in mammals known as metapophyses, they may bear the same general name, being distinguished as the post-metapophyses. The term pre-metapophyses should then be applied to the processes in mammals.

The post metapophyses probably serve for the attachment of ligaments in the place of the neural spine, which is here wholly wanting.—These processes, which are at first oblique in position, gradually become more vertical and stouter, and, coalescing at their bases, finally become united throughout, and are thus converted into the neural spine.

FŒTAL DINOSAURUS.

Remains of a very small dinosaur were found in immediate relation with the type specimen of *Morosaurus grandis*. These remains, which consist of a complete femur, the larger portion of both humeri, and several vertebræ, show no essential differences from the large specimens except in size, and indicate an animal of perhaps seven feet in length, and little more than two feet in height. The imperfect ossification of these bones indicates that the animal was very young, and it seems probable that it was fœtal. The only other similar case known in the *Dinosauria* is the apparent embryo observed by the writer in *Compsognathus*.

CLASSIFICATION.

The various genera of the *Sauropoda*, and in fact of the *Dinosauria* in general, cannot at present be distinguished by the detached teeth. In one form, however, the teeth are quite peculiar and the dentition appears to offer generic characters. The maxillary teeth of this form have been referred to *Stegosaurus*, as they were first found in connection with the remains of that genus. Later investigations indicate that they belong to the *Sauropoda*, and there is some evidence that they are the teeth of *Diplodocus*.

The main characters of the order *Sauropoda*, and of the two families now known to belong to it, are as follows:

ORDER SAUROPODA. Herbivorous.

Feet plantigrade, ungulate; five digits in manus and pes; second row of carpal and tarsal bones unossified. Pubes projecting in front, and united distally by cartilage; no post-pubis. Fore and hind limbs nearly equal; limb bones solid. Sternal bones parial. Premaxillary bones with teeth. Precaudal vertebræ hollow. Each sacral vertebra supports its own transverse processes.

Family *Atlantosauridæ*. Anterior vertebræ opisthocœlian. Ischia directed downward, with extremities meeting on median line. Anterior caudals with lateral cavities. A pituitary canal.

Family *Morosauridæ*. Anterior vertebræ opisthocœlian. Ischia directed backward, with sides meeting on median line. Anterior caudals solid. Pituitary fossa only.

Yale College, New Haven, July 12, 1888.

THE MUSK CATTLE OF AMERICA.

By DR. G. A. STOCKWELL.

DURING the earlier days of our continent, and just prior to the "drift period," the plains and valleys of that which is now the central portion of the United States nourished considerable herds of dwarfed cattle, clothed in long, hairy fleece—the *Bos bombifrons* and *Bos latifrons*, described by Leidy. Possibly, also, the remains of oxen found in upper Siberia and the Lachoo Island may have been of the same or a kindred race, as well as the *Bos pallasii* of De Kay; while the fossil relics of Eschscholtz Bay, Greenland, and the valley of Treetholt River, of Alaska, are almost identical with an existing form. To-day, however, the Old World exhibits no representatives of the race, while in the New the immediate descendants, if such they are, are confined to the extreme and most dreary portions of North America, and to a range that is gradually becoming more and more restricted in its southern and western limits.

Evidences are not wanting that musk oxen ranged at a comparatively recent date far into the borders of the wooded belt, descending as low as the southern shores of Hudson's Bay, to the west reaching the valley of the Yukon and sterile shores of West Georgia, Alaska, non-fossilized remains being frequently brought to light. Scarce a century since, Samuel Hearne observed their fresh tracks within two miles of Prince of Wales Fort, now Churchill House, and every autumn brought hundreds about the north shores of Athabasca Lake; but now many a weary mile must be traversed from either point ere a single individual of the species is encountered, few descending below latitude 65° N. Indeed, the limits of the race are almost exclusively those of the Barren Grounds—that practically treeless and barren waste that stretches from Great Slave and Bear Lakes, east to the extreme verge of Melville Peninsula, and north to the shores of the Polar Sea, embracing its bewildering maze of islands.

On the hither side of the Atlantic we are accustomed to speak of the animals as *oxen*, out of deference to certain osteological characteristics, merely adding the prefix of *musk* as a specific indication, bestowed in consequence of the effluvia always given off by all members of the race, old and young, male or female, though most marked in summer, particularly with old bulls in August, which is the wooing season. Our insular brethren, the English sportsmen more particularly, insists upon the title of *musk sheep*, basing upon certain characteristics of the hair with which they are clothed, a faint ovine contour of head and horns, the small round excrement like that of the sheep or hare, and the modest stature, which is more than exceeded by the famous Kyloe kine, or dwarfed Highland cattle. The horns, however, are smooth and round, lacking the three-cornered, wrinkled appearance and peculiar symmetrical curve of the ram, while the nose and muzzle, the flat forehead, the peculiar character of hoof, and general anatomical outlines are unmistakably bovine. Nevertheless, the similarities, especially under cursory inspection, are sufficiently marked to lead to many curious and interesting muddles, more particularly as science has assumed a middle or neutral position and denominates it the *musky sheep-ox—Ovibos moschatus*.

Taking all circumstances into consideration, including habits, form, and range, the musk-ox is a somewhat remarkable as well as anomalous animal. Imagine, if possible, a creature scarce five feet long from tip of its outstretched nose to the root of tail, but a yard high, or, at most, three feet six at the withers, and weighing but four or five hundred pounds when in prime condition; a small body set low on its legs and appearing considerably larger than it really is in consequence of its heavy fleece of hair that on the neck, brisket, flanks, and under parts attains a length of half a yard, hanging considerably below the knee; a pair of small, intensely wicked blue eyes, set well forward; a soft, downy muzzle, with two enormous nostrils that seem almost blended into one; pointed ears, three inches long and of equal breadth in their middle, but nearly hidden by the surrounding hair; trim, deer-like legs set in hoofs of prodigious size, and a pair of huge horns falling down on each side of the head with a forward curvature; imagine all this, and you have a faint perception of the *tout ensemble*.

The most astonishing features, perhaps, are the horns, hoofs, and fleece, the first and last having no parallels among existing forms of life. The horns of an old male are ponderous affairs, weighing perhaps fifty pounds, joined at their bases, where they have a circumference of two feet, then fall over the sides of the head with an outward ten-

dency and slight forward curve, tapering rapidly, and suddenly turn up in hard black pointed tips an inch or two above the level of the eye; yet their measurements along the curve are not in excess of their diameter at the center of the fine head. Those of the cow, however, are considerably smaller, are nine inches in circumference at the base, and nine inches apart, springing directly from the angle of the frontal bone, and measure but a foot or fourteen inches along the curve, and the polished points, instead of turning up, are projected forward in a horizontal line just *below* the level of the eye.

The hoofs are so exactly like those of the Barren Ground caribou or northern reindeer, as to require an expert hunter to distinguish the tracks of the one from the other, though it is claimed for those of the deer that they are a trifle narrower and more pointed. The frog of the hoof is soft and exceedingly elastic, and, moreover, well padded with the long hair that hangs down about the fetlock, and grows even between the divisions of the hoof. The divisions, too, are widely separated, even up into the pastern, allowing great lateral spread, and the external half is longer, more pointed, and overlaps and curves about its fellow when the foot is at rest. The lateral hoofs, which in domestic cattle are merely rudimentary, and serve no apparent purpose, are enormously prolonged, with an outward and backward inclination in order to reach the ground, and consequently afford a greater bearing surface to each foot—a wise provision of nature that enables the creature to traverse the vast morasses and swamps of its habitat in summer, or move lightly over deep snows in winter. The edges of the hoofs, too, are extremely sharp and clean cut, permitting the wearer to race at full speed over ice or frozen snow, traverse broken ground, or to scale considerable heights with all the ease and agility of the goat; they also constitute powerful weapons for offence or defense.

The tail, which is scarce more than four inches long, and formed like that of the bear, is so hidden by the hair of the surrounding parts as to be practically invisible, and long was supposed to be entirely wanting. Mr. Ellis, in the published account of his voyages to Hudson's Bay, nearly two centuries ago, asserts that the Innuits ("Eskimo," he calls them) made of the tails of musk oxen peculiar ugly caps, the long hairs of which fall to the breast and shoulders, shrouding the face, and which were worn as a protection against mosquitoes. He must have fallen into an error, however, since the hairs on the tail are but about three inches in length, and the "mosquitoe wigs," Hearne informs us, are constructed from the long, coarse hairs of the brisket or flanks.

The fleece consists of two coats, the long, coarse hair of the coat proper, and a finer one beneath, very close, compact, and woolly in character, in midwinter having almost the consistency of felt. It is this thick undercoat that enables its wearer to withstand the rigors of an extreme Arctic winter, even in the highest latitudes, and which has been seized upon as a pretext for denominating the animal a *sheep* rather than *ox*. The prevailing impression is that "wool" is confined to sheep, but experience proves that with but very few mammals the external covering is a variable mixture of hair and wool. Of the two extremes of hair, one is rigid, shining, coarse, and well fixed, constituting the "jarre" of manufacturers, and which exists nearly alone in the ordinary conditions of the horse and ox. The other hair, or down, hidden under the first, and developed by removal to higher latitudes, or by marked attention to breeding, is distinguished by being more curled and tangled, and more dull than "jarre," as well as much finer; and this is the "wool" which exists nearly alone in the Merino sheep and Cashmere goat, and greatly preferred by manufacturers not only because of its fineness and tendency to curl, but also because it bristles with little scaly asperities (due to its mode of development) which render it more adapted for felting and transformation into tissues. Under such circumstances "wool" cannot be held indicative of race or family, but of breeding, and of a wise provision of nature to enable her creatures to secure and retain latent animal heat as it may be required for comfort and existence. And this is its purpose with the musk ox; and, having served that purpose, becomes loosened in the spring and drops out, being aided by the frequent rollings and scrapings the animal indulges in, until by midsummer only the long "jarre" remains. The season is so short, however, that the new fleece quickly appears, and grows so rapidly that by the time winter again appears the wearer is fully prepared to encounter it.

Musk ox "wool" is of a light gray color, and of such exceeding fineness and delicacy of texture as to have excited the admiration of all who have beheld it; and it is claimed that could it be obtained in sufficient quantities, it would quickly replace the product of the silk worm in all the finer manufactures. The dreary, inhospitable, and almost inaccessible solitudes inhabited by the animal, however, effectually precludes such a possibility, though on several occasions articles of clothing have been made of it, though produced as objects of curiosity rather than for any commercial purpose. Something like a century and a half since, an enterprising Frenchman, one M. Jeremie, caused some of this fleece to be woven into a pair of hose which were presented to one of the mistresses of the King of France, and which not only commanded the admiration of all who beheld them, but excited the cupidity and jealousy of all the high born dames at court, even to the queen herself.

Though considerable numbers of musk oxen winter in extreme latitudes, both on the mainland and the islands of the Arctic Sea, a portion, at least, more particularly those of the eastern extremities of the Barren Grounds, become migratory with autumn, moving toward the west and south, where they linger until the advent of spring, when they retrace their steps, feeding slowly, and keeping pace with the rapidly springing vegetation. These migrations, too, are irregular—more general during certain years than others, at times amounting to virtual depopulation, but without seeming relation to severities of season or climate. They are more apt to occur after an unfortuitous summer, if the testimony of native tribes may be taken, and hence it may be presumed they depend solely upon food supply. At times they appear in overwhelming numbers in the vicinity of Wager Bay, Chesterfield Inlet, the Coppermine, and Great Bear and Slave Lakes, until the landscapes are fairly black with moving herds, while on other occasions, though present, they are remarkable only for the infrequency with which they are encountered.

Commonly the shores from Wager to Repulse Bay are well inhabited throughout the year, and Chas. Francis Hall remarks the frequency with which he met them to the northward of Repulse Bay, along with other forms of game peculiar to the region, especially during the winter he visited King Williams' Land and the shores of the Gulf of Boothia. Both going and returning, there was no lack, his note book chronicling the killing of ninety musk oxen alone, and causing him to give expression to the following: "Oh, would that I could have met Crozier and his party twenty-one years ago with the facilities I have had on this journey! I am sure I could have saved the whole company. I say it with no egotistical feeling, but with a confidence of what I know of the country."

Even in the smaller islands of the polar archipelago, musk oxen are not necessarily absent even in summer, since they are powerful swimmers, and so much at home in the water that considerable stretches of sea do not impede their progress. They have several times been encountered in Greenland, in spite of the general assertions and popular belief that they are unknown to the island; and they visit, if they are not constant inhabitants, Cumberland, Cockburn, and North Devon Islands, and even Grinnell's Land. Sir John Franklin, in assuring us of their intrepidity in taking to water, and their almost unexampled natatory powers, relates the killing of one on an island miles away from any other land, and which, during an examination and careful exploration the day before, revealed no form of animal life greater than Arctic foxes and hares; and the damp condition of the fleece of the ox was of itself sufficient evidence of the journey it had performed.

There is no doubt concerning the excessive hardihood of a race that inhabits so bleak and inhospitable a region, and even here evinces a preference for stony and rocky grounds almost barren of vegetation; and consequently the sustenance usually obtained must be of the most simple and primitive character, and limited chiefly to lichens and mosses. Hearne declares they have a fondness for grasses, preferring to any other form of food, but that they also browse largely on the branches of such trees as they may encounter within their reach. The contents of stomachs examined also reveal the remains of bark, twigs, and leaves of dwarfed firs, willows, and birches, such as grow in the immediate vicinity of the numerous water courses in the Barren Grounds, beside the reindeer moss (*Cladonia rangiferina*) and the *tripe de roche* (genus *Gyrophora*). In certain localities, too, they have been observed feeding upon Labrador tea plants (*Ledum palustre*) and also the black-crow berry (*Empetrum nigrum*), which grows even more abundantly in the wastes of the far north than on the sterile hills of New Hampshire. But in winter their food must consist largely of the caribou or reindeer moss, and such lichens as may be uncovered from beneath the snow with the aid of the sharp hoofs; and the animal is possessed of such unerring instinct or smell that such a thing as failure is unknown. Apropos of the *Cladonia rangiferina*, and more especially the *tripe de roche* which figures so largely in the annals of Franklin, Richardson, and Back, and upon which they sustained life for days at a time, it may be mentioned that they are very rich in alcohol—another convincing argument that alcohol is far more of a food than ultra reformers are willing to admit.

As with most ruminating creatures, musk oxen are naturally and essentially gregarious; more so perhaps in winter than in summer, in order to obtain the full advantage of mutual warmth. Herds of various size are encountered, from those of three and four or half a dozen individuals up to eighty, one hundred, and more, and each gathered under the direction and immediate leadership of some patriarchal bull who has won the distinction at point of horn and hoof in many a fiercely contested battle; and this leadership is retained through life, or until overpowered and driven forth from the herd by some agile and active rival. These old chieftains are often of considerable age, as evinced by the character of their horns, the wrinkled eyelids, deep set sockets, prolonged hoofs, and general grizzled appearance. With them "might is right," and, in consequence, the number of bulls is very few in proportion to cows in the herd, and in the largest rarely exceeds three or four; while the number of males found each year, more especially in autumn, by trappers and hunters, gored and trampled to death by their fellows, or so maimed as to have fallen a prey to the fierce gray wolf of the North, proves that their love jousts and tournaments are no common affairs, but conducted with a fierceness and bitterness of spirit that ends only with complete annihilation. Again, during the rutting season, the old leader of a harem is so insufferably jealous of his mistresses that he can scarce allow himself time to feed in his watchfulness, and flies at every living thing that ventures to approach, even running after and bellowing fiercely at foxes or ravenous birds of prey that may chance to alight in the vicinity. And in spite of his diminished form and appearance, he is no despicable foe for even man to encounter at this season, quickly assuming the offensive, and charging with a fierceness and wickedness indicative of his purpose if opportunity favors. Fortunately, however, in spite of certain natural agility, he is much more adroit in a rush than otherwise, and cannot bring up with the agility essential to a quick wheel or turn, and may be easily avoided by nimbly stepping to one side; and once out of his range of vision, he quickly forgets his rage, often apparently forgetting the *casus belli* the moment he has plunged by in headlong career; the peculiar set of the eyes, too, which allow of but limited range, renders it a matter of little difficulty to avoid his glances.

The cow brings forth but a single calf, either during the last of May or first weeks of June. She separates from the herd prior to her accouchment, and remains absent for four or five weeks, hiding her offspring in some quiet retreat, and watching over it with constant solicitude lest it should be discovered by wolves or males of her own race. She is very fierce, too, now, exhibiting a disposition akin to that of her amorous lord, with the advantage of being quicker on foot, and using hoofs and horns with equal dexterity. A cow has been known to put to flight a pack of a dozen wolves, though not until half their number strewed the ground as trophies to her courage and prowess. During these weeks of solitude, her calf is but a helpless and weakly thing, all head, muzzle, and legs, scarce able to stand alone, much less totter after her; after the fourth week, however, it grows rapidly, and when two months old is able to feed and care for itself nearly as well as any member of the herd.

The Innuits hunt the musk oxen with spears and dogs alone, depending upon the latter to keep the herd together; certain as long as the dogs bay, not one will stir from the post he has taken. No sooner are the curs released than the herd form a circle with tails toward the center, presenting on the exterior circumference only a solid ring of battering foreheads and sharp horns. The dogs seem to occupy their sole attention, for the men approach within a dozen feet or little more and ply their spears, withdrawing them after each thrust by a line attached to the handle and held in a coil in the left hand. Now and then an enraged and wounded bull or cow ventures on a charge, when it is avoided by a quick leap to the right or left; and soon the herd is so decimated they take refuge in flight. One peculiarity the musk ox has when preparing for battle is the whetting of the points of his horns, first one and then the other, alternately, against some rock or bowlder, and in the absence of these, drawing them across his fore legs.

The Coppermine and Dog-rib Indians, however, stalk the herds, creeping up from the leeward by taking advantage of every hollow and depression, or intervening bush or rock, until within shooting distance. This is not usually a difficult matter, except during the season of rut, since they are not especially alert while feeding. Indeed, it is sometimes possible to move up within shooting distance in the level open, by merely standing motionless when one of the herd lifts its head, moving rapidly and noiselessly as the heads are all down, taking care, of course, that the herd do not get the wind. Guns are used to some extent, but do not appear to excite any particular alarm on the part of the cattle, who merely lift their heads at the report, appear astonished at the fall and death throes of their comrades, and then huddle closer together and go on feeding; and in this way the better part of a herd may sometimes be bagged before they become sufficiently alarmed to take to their heels. Arrows and bows also are used to good effect by these natives, the latter being a unique engine of its kind, consisting merely of three pieces of fir neatly tied together and whipped with sinew, the center alone of which is bent, the two forming the ends lying in the same straight plane as the bow string. Another mode of hunting is to build extensive ranges of stone or turf hillocks, behind which a portion of the hunters hide, while others, making a wide circuit, come down upon the herds from the windward, driving them up slowly to their comrades, who are thus enabled to select at leisure the calves and most desirable cows at will.

When in good condition, the flesh of cows and calves is by no means unpalatable, smacking more of venison than of beef, but coarser in fiber, a trifle less juicy, perhaps, and scarce so well flavored; and great care must be needs taken in dressing to prevent contamination and consequent musky flavor of the meat. The flesh of lean animals, however, is always musky, and of old bulls both musky and rank, so much so as to be utterly uneatable, and is rejected even by the strong stomach of the savage, save under the compulsion of hunger and starvation. The fat is well flavored and by many trappers and fur traders esteemed an excellent substitute for butter; it is exceedingly hard and clear, and pure white in color, or white faintly tinged with azure.

The musky odor, which may sometimes be detected a mile away to the leeward of a herd with the wind blowing strongly, is decidedly unpleasant, sharp, and penetrating. It is common to both sexes alike, though strongest in old males, especially during the breeding season; and while it undoubtedly bears a marked relation to the sexual function, is nevertheless apparent throughout the entire glandular system. It is excessive in connection with the intromittent organ of the male, where it seems to proceed from a gummy secretion that exudes from the prepuce and glands—a species of smegma, perhaps; and hard and dried resin taken from males killed nearly two centuries since, and preserved in the British Museum, still give out the peculiar odor, without apparently having lost in the least its intensity. Hearne supposed the odor to be connected with the functions of the kidney, or perhaps a secretion of the urethra, a mistake not at all unnatural to one ignorant of the physiology of these organs and of the generative functions; it may, however, yet prove to be a secretion of glands analogous to those of Cowper and Bartolini in the human race.

A musk ox hide, when dried, weighs not far from ten pounds; and that of an old bull is of such exceeding toughness as to be used in lieu of sole leather, being much more durable. The hides of cows are softer and finer, and when dressed after the Indian fashion are equal to the finest chamois in softness and pliability, are almost impervious to cold or water, and possess the happy faculty of never shrinking or becoming harsh when submitted to the prolonged action of moisture. They are much sought after for coats, shirts, leggings, and moccasins, and in the manufacture of the sleeping bags so essential to the comfort of every traveler in the far North, some thousands of skins being utilized in this way every year. As it is, the demand is far in excess of the supply, and consequently few or no skins find their way to market.

Illustrative of the chances of accident that will occasionally occur to the hunter and sportsman, and the presence of mind essential to one who essays a wild life and hopes to return in safety from a trip to the comparatively unknown tracts of the northern portions of the continent, I subjoin two anecdotes as related by that prince of sportsmen, Captain Parker Gillmore:

"The ice had just disappeared from the rivers, and the thought struck me that an alteration in diet of fish for fowl would be most acceptable to the palates of the encampment. A couple of miles distant was the river, and in an hour I had secured more trout than I was disposed to carry; so, work being over, I treated myself to a pipe. While enjoying my tobacco, a wading bird, of a description I never before saw, lit close by me. It was so tame that I threw several stones at it, almost with success, for the distance was not over ten or fifteen yards, before it took to wing and went further down the stream. Anxious to procure a new specimen, I followed until almost a mile lay between me and my fish. To save distance in returning, I determined to cut across the angle formed by the bend of the river, and had progressed about half way when I saw a female musk ox coming after me. When a lad in the Highlands, I had been dreadfully punished by a tup, and the remembrance of the event had not yet been forgotten. A mountain ram is a small beast compared with my pursuer, but *he* was able to do enough mischief. The ground was roughly sprinkled with bowlders, some of great size, and for the most inaccessible of these I made the best speed I could muster, and only succeeded in gaining a place of safety when the cow's horns were within a foot or two of my hurdies. For over an hour she kept watch of me; and worse than all, when I got back to my fish, some vermin or other had carried all the best ones off, and it was getting too late to catch a fresh mess. When at the fort the Indians soon explained the reasons of this unprovoked attack, and proved the correctness of their assertion by shooting the mother next morning and bringing the calf home, which we were unable to keep alive for over three days, much to the regret of all.

"Again, in stalking some caribou, eight musk oxen crossed directly between me and the deer. I was well hid at the time, so that they came unsuspiciously within thirty yards. In a moment I gave them both barrels. To the first shot an old bull dropped and rolled into the ravine; the second barrel crippled a three-quarters grown cow so badly that I knew less than a mile would lay her up. In my hurry to secure the old one, without loading I hurried to the ravine. There he was, as I thought, in the last struggle. Down I jumped into the hollow, which was about ten feet deep;

but no sooner did he see me than up he got, and, head down, charged. I turned tail, and fortunately scrambled out a wiser man; for deil tak me if ever I gang near ony o' them again without baith powther and lead in my gun."

[KANSAS CITY REVIEW.]

THE SOLAR ECLIPSE OF MAY 6, 1883.

WE cull the following items from the reports of Professors Holden, Hastings, and others, regarding the journey to Caroline Island and the phenomena of the eclipse as observed by them on May 6. Professor Holden's report is made to Professor C. A. Young, Chairman of the Eclipse Committee of the National Academy of Sciences, and contains some details concerning the voyage and the stay of the observers on the island which, while out of the usual run of official reports, will be none the less interesting to the readers of the *Review*. Prof. E. S. Holden belongs to the U. S. Naval Observatory, but is temporarily in charge of the Washburn Observatory, at Madison, Wisconsin, and was the principal officer of the American Expedition:

Journey from New York to Colon (1,989 miles), from Colon to Callao (1,729 miles), and from Callao to Caroline Island (4,324 miles). The six members of the American party sailed from New York March 1, 1883, on the Pacific mail steamship Acapulco (Capt. W. Shackford), and arrived at Colon March 11, after touching at Castle Island, March 7, to send off a mail. At Colon the expedition was joined by the English photographic party. As the steamer on the west coast of South America did not leave until the evening of March 12, the American party remained in Colon till the morning of that day, and went thence to Panama.

Every day during May a rehearsal for the eclipse observations was gone through with, and two days before May 6 everything was in complete readiness. On the morning of May 6 there were three showers and several persistent banks of clouds. The sky was clear at first contact (about 10 h. 3 m. local m. t.), cloudy at intervals till near totality, clear during totality, except slight haze during the first minute of totality, cloudy a few minutes after third contact, and finally clear at fourth contact. The observations of the various parties may be considered to have been successful. But the success was owing to the apparent accident of the dissipation of a local cloud. I am more than ever convinced that my conclusion to go to Flint Island, had I found the French party occupying Caroline Island, was a sound one.

On the twenty-third day out from Callao, we sighted one of the islands of the Marquesas group, and at 8 A. M., of April 20, Caroline Island was seen as a low green streak on the horizon. We had come 4,324 miles in twenty-nine days, mostly under sail (an average of 149 miles per day) without seeing a single sail or any land, except Magdalena Island, of the Marquesas, which we had gone out of our course to sight. I cannot refrain from quoting here Darwin's entry in his "Journal of a Voyage in the Beagle," under date of December 19, 1835: "We now consider that we have nearly crossed the Pacific. It is necessary to sail over this great ocean to comprehend its immensity. Moving quickly onward for weeks together we meet with nothing but the same blue, profoundly deep ocean. Even within the archipelagoes the islands are mere specks, and far distant one from the other. Accustomed to look at maps drawn on a small scale, where dots, shading, and names are crowded together, we do not rightly judge how infinitely small the proportion of dry land is to the water of this vast expanse."

It must be remembered that we knew absolutely nothing of Caroline Island, except that it had been inhabited in 1874 by at least one white man and some thirty natives. The boat landing was known to be somewhere on the southwestern side, and an "entrance to the lagoon" was spoken of on the eastern side. The Hartford approached the island from this side, and from end to end there was nothing to be seen but a line of heavy breakers, then a strip of white beach, and above this a growth of trees, the highest of which were cocoa palms. Finally in among these was seen the gable roof of a European house, but no inhabitants. Coasting round the island, everywhere surrounded by high surf, the Hartford came opposite the place where the boat-landing was reported, and the whaleboat was lowered, and Lieut. Qualtrough sent in her to land, if possible. It seems all very simple now, after Caroline Island, its reefs, its lagoon, and its landing are as familiar to us as the beaches of New England; but at the time it was all quite strange and new. The advent of a man and dog on the reef was an event. It seemed to settle one thing at least, and that was that we should find some assistance in landing. But the native disappeared, and Lieut. Qualtrough was left to find his own way among the breakers, which he did in a capital manner. The ocean reef forms a solid wall all round the island, except at one narrow and crooked entrance, just wide enough for a boat and oars, and through this entrance each boat must come, or be broken into bits against the steep face of the coral wall. The whaleboat returned shortly with the news that there were four native men, one woman and two children on the island, that two frame houses were standing, and that we could land at once.

At high water this ocean reef was covered to a depth of about thirty inches, and at low water to about ten inches. The boxes were then lifted from the boat, and transported by carrying parties to the high water mark, a distance of 1,400 feet. This transport had to be made over the ragged surface of the ocean reef and through water of a depth varying from one to three feet, as I have said. From high-water mark, other carrying parties transported the boxes along the beach of the lagoon and across the island to the site of our observatories (some 1,300 feet further), which had been selected by Dr. Hastings and myself. On board the Hartford I had prepared a plan of the proposed camp; the position of each observatory was fixed on the ground by a stake, and to this stake all the boxes of each instrument were brought. In this way all proceeded in an orderly manner. By the evening of the twenty-first all the boxes and baggage of the expedition were landed, as well as bricks, cement, lumber, etc., for the observatories.

The entire party slept on shore also; and I shall never forget the quiet rest of that cool night after the intensely hot day of active work. Our hammocks were swung on the wide veranda of one of the houses, close to the beach of the mirror-like lagoon. The wind was cool and fresh as it blew through a break between two of the islands and directly from the open sea, the monotonous roar of whose surf was incessantly heard. The nearly full moon was overhead, and the long fronds of the cocoa palms made grotesque shadows on the level ground. Occasionally there would be heard the shill cry of some sea bird flying over, and other than this and the roar of the breakers there was nothing to disturb the quiet and rest which came as a fitting conclusion to our restless month at sea.

During the 22d of April the Hartford remained by the island, and a force of carpenters and bricklayers proceeded rapidly with the construction of our observatories. By night-time the observatories belonging to myself, Dr. Hastings, and Mr. Preston were up, and piers of brick or wood completed. The brick piers of the English party were well under way, and were completed on the 23d by Mr. Wood, who thus added a new profession to his former acquirements.

The Hartford sailed at 6 P. M. of the 22d for Tahiti, and some of us went to the ocean reef to see her off. Besides her lights we saw those of l'Eclaireur, the man-of-war which was bringing the French eclipse expedition. Early on the morning of the 23d I met the maitre d'equipage of the l'Eclaireur on the reef, and gave him such information as to the landing, etc., as I was sure would be of use. Shortly after this the French party came on shore for the day, and the morning was spent in aiding them to select a site for their observations, etc. This party consisted of M. Jansen, director of the Observatory of Astronomical Physics of Meudon; M. Trouvelot, assistant of the Meudon Observatory; M. Pasteur, photographer of the Meudon Observatory. These gentlemen were accompanied by M. Tachini, director of the Observatory of the Roman College; M. Palisa, astronomer of the Imperial Observatory of Vienna. Besides these astronomers there were seventeen of the crew of l'Eclaireur left on shore, making the French party twenty-two in number. Thus the total population of the island was fifty-one in all, including natives. Our relations with the gentlemen of the French expedition were throughout of the most cordial character. So far as our researches lay in the same direction, we worked together to a common end. It was a pleasure to us to be able to extend to them what aid was possible, and to receive the same in return.

During the remaining days of April everything was making progress toward complete readiness for observations of the eclipse. The observatory of Dr. Hastings and my own were completed by April 27, and each of us used a six-inch equatorial for some hours each night in an examination of the southern sky. During the course of this we detected some new doubles and red stars, a list of which is given later.

The vision was not especially good, and comparatively few hours were given to telescopic work, owing to the impossibility of obtaining a quiet sleep during the day. Still, new double stars were found. This shows that if a suitable telescope were to be used in a favorable place in the southern hemisphere, at Quito or Santiago for example, a great number of new objects could be catalogued in a comparatively short time. It appears to me that this expedition is worth making. Immediately after the eclipse we commenced preparations for departure. These occupied May 7 and 8, and at 5 P. M. of May 9 the Hartford, with the expedition on board, took her departure for the Sandwich Islands. We left Caroline Island with mingled feelings of pleasure and regret. Each one of us had at least some one thing left to do or to see, and yet it was a pleasure to leave the place where our mission had been accomplished, and to meet our friends in the ship, who were endeared to us by that intimacy which sea life induces.

It may be added, as Professor Holden's modesty excluded it from his report, that there was a spirited race between the French and American expeditions, of four thousand miles from the coast of South America. Each desired to reach Caroline Island ahead of the other in order to secure first choice of locations.

[To be continued.]

THE USE OF PARIS GREEN.

ALMOST every week we find paragraphs in our exchange papers recommending the free use of Paris green for destroying insects on fruit trees and garden vines, and about equally often accounts are published of cases where human beings or valuable domestic animals are poisoned by coming in contact with the Paris green, either upon food eaten, or by particles of the poison dust getting into sores or scratches in the flesh. The *New England Farmer* does not oppose the judicious use of Paris green for the destruction of the potato beetle and some other insects, but we would have our readers remember that this is a poison that is as dangerous to man and animals as to insects, and that too great caution cannot be observed in its use. And first, it should be known that an almost infinitesimal amount, if eaten by an insect, will cause death in a few hours. When using the poison upon potato vines, or upon fruit trees, the aim should be to make the green go over as much ground as it will effectually cover.

We have known of several potato fields being badly injured the present season by too free use of the dust upon the leaves. A leaf killed by the green is as useless to the plant as one eaten by the bug. We have generally applied the poison dry, and mixed with very fine plaster of Paris at the rate of one part in weight to one hundred parts of the plaster, and then without making a very heavy application the beetles have been throughly cleaned out. It is only necessary to have the poison remain on the leaves two days to destroy all that partake of it. Later hatchings may require subsequent applications. As the insects are found upon the tenderest leaves, those which grew last, there is no necessity for dusting over the whole of a large hill of vines, but a little poison shaken into the central portions of the stems will be quite as effectual. If one has a large field to treat, it would be well to cover the mouth and nose with a thin cloth wet in cold water, while doing the work, and special caution should be taken against getting a particle of the dust into any flesh wounds or sores on the hands, feet, or face.

The past season, we have applied the poison in water, through a small sprinkler, which worked better than anything else previously tried. One teaspoonful of the pure green in two and a half to three gallons of water was found sufficiently powerful to destroy all the weevils within two or three days after the application. This is putting it on so thin that no color could be seen on the leaves, but it was there, nevertheless, and the beetles probably ate it more readily than if mixed with plaster, which is always more or less gritty.

For applying to trees, the water application is doubtless far best, but the poison cannot safely be used in an orchard that is being pastured, nor on trees to which horses are liable to be hitched, nor would we be willing to sprinkle trees in mowing fields, or corn fields, where the fodder was soon to be cut for feeding. Nor would we use the poison upon any fruit that was nearing ripeness. The application to apple trees for destroying the canker worm and codling moth, should be made early in the season only; the later broods of the codling moths must be treated by other means.

All utensils used for applying the poison should be thoroughly cleansed before being put away, and the partly used packages must be tightly wrapped, marked, and stored where children will not get them. Empty cans and boxes that have contained the green should not be left carelessly lying about in the fields or out-buildings, as we have too often found them, but should be carefully burned or buried. Potato tops that have been poisoned ought not to be fed to cattle nor thrown in the pig pen. Fear may be foolish, but caution is wisdom.—*N. E. Farmer.*

HOMES FOR THE POOR.

ACCORDING to facts collected by the New York *Tribune*, it pays, in London, to spend money directly in the line of public sanitary and economic improvements. A company in London holding 3,300 houses, built for rental to workmen, laborers, and factory operatives, receives an income of five per cent annually. This same company is extending its work to North London, where it has secured an extensive area of 100 acres. This will be known as Noel Park, and will comprise 2,600 houses and a recreation ground of eight acres. The *Tribune* says that the best friend the tenement population of New York could have would be the man to build several blocks of model homes for working people, complete in their sanitary appointments and well lighted and well ventilated, and to make ten or twelve per cent upon the investment. Let one man succeed in doing this, and a fair share of the capital now going into the luxurious apartment houses of the rich would be invested in habitations for humble laborers and their families.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
261 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—The Suez Canal.—A general description of the great work, with maps, plans of the entrances, plan of the canal and the projected alternative canal, and a portrait of De Lesseps 6355
The Submarine Monitor.—A new electrical torpedo, with full particulars of construction and operation 6359
De Woelfert's New Aerial Ship.—Lately tried in Germany, with an engraving 6371
The Jointing and Testing of Gas Mains.—A valuable paper. By C. W. FOLKARD 6377
An Improved Pipe Cutting and Threading Machine.—With engraving 6378
The Dresden Victoria Knitting Machine.—With several engravings 6379

II. TECHNOLOGY.—Wax. By LEOPOLD FIELD.—An interesting paper, descriptive of the qualities and sources of various kinds of wax, animal and vegetable.—With illustrations 6365
How to take Artistic Photo Pictures of Landscapes 6369
The Centaur.—A bronze design for a fountain.—Engraving 6369

III. ELECTRICITY, HEAT, ETC.—Progress in Telephony.—Morin's solenoid candle.—With engravings 6365
On Certain Phenomena Manifested by Liquid Vortex Rings. By T. HART.—Several illustrations 6366

IV. NATURAL HISTORY.—Restoration of Brontosaurus. By Prof. O. C. MARSH. With an engraving showing the osseous frame of an individual fifty feet in length 6366
The Musk Cattle of America. By DR. G. A. STOCKWELL. An interesting paper 6368
The Glacial Period in Illinois. By WILLIAM M. ADAMS 6367

V. ASTRONOMY.—The Solar Eclipse of 1882 as seen at the Caroline Islands 6360
Stellar Photography as Practiced at Harvard 6360

VI. MEDICINE, HYGIENE, ETC.—Sleep and Dreams. By W. S. POLAND, M.D 6365

VII. MISCELLANEOUS.—Professor Huxley in his Study. With a sketch taken from life 6367
The Use of Paris Green on Plants 6360
Dr. Hooke. By C. STUART MURRAY. An interesting account of the life and discoveries of the great philosopher 6363
Galleries of the Institute of Painters in Water Colors.—With an engraving 6361
What Drainage Does 6361
Wooden Taps 6362

PATENTS.

In connection with the **Scientific American,** Messrs MUNN & CO. are Solicitors of American and Foreign Patents, have had 38 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all Inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured. Address

MUNN & CO., 261 Broadway, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.